Connected Motorcycle Consortium

CMC Basic Specification

Accident Analysis

- Additional Crossing Traffic

Advanced analysis of accident types: Additional Crossing traffic based on GIDAS (German In-Depth Accident Study) database.

Document Information

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Disclaimer

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1. Background and Objectives

To pursue the goal "improving motorcycle rider safety and comfort", CMC has studied the most frequent Powered Two Wheeler (PTW) accident scenarios in the GIDAS (German In-Depth Accident Study) database in which PTWs become the victim of accidents they did not cause (Figure 1). Out of those accident scenarios, crossing traffic scenarios in which PTWs become the victim of accidents they did not cause are found to be 17.5% of the total of PTW accidents. CMC already performed a study for crossing traffic of accident type 302. In addition, this report explains the analysis result of the crossing traffic of accident types 301 & 303 and 321 & 322. (See Chapter 3)

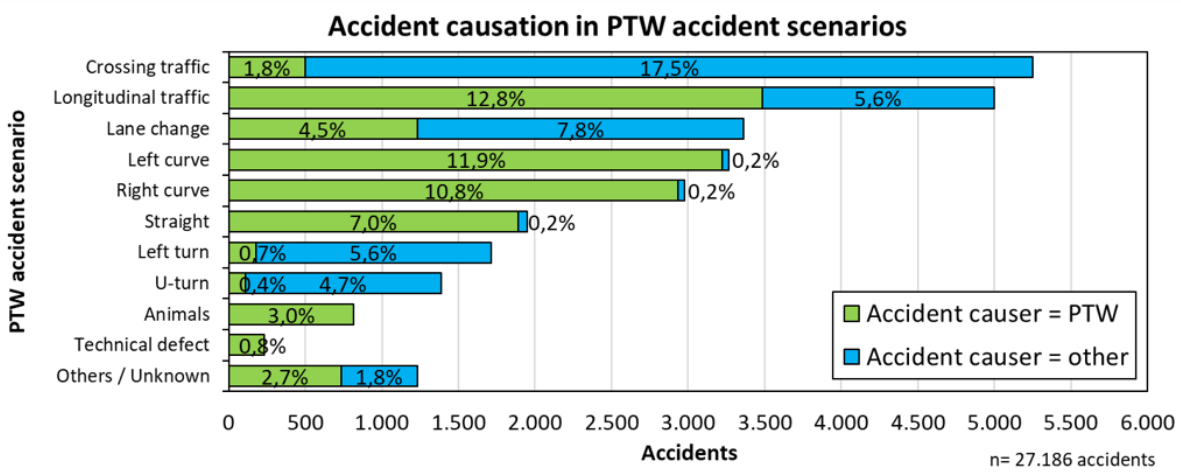

Figure 1: Accident causation in the PTW scenarios

2. Study structure

Accident analysis of the use cases is a fact-based analysis using the GIDAS database.

Analysis contents

This study uses the GIDAS database which contains precise information of the actual accidents occurred. From the database, the following fact-based data are extracted and studied.

a) Location of the accident: rural / urban
b) Accident scene: straight / bend / junction, etc.
c) Kind of traffic regulation: right of way / stop sign / traffic lights, etc.
d) Kind of road user: M1/N1, M2/N2, motorcycle, bicycle, etc.
e) Main accident causer
f) Main accident causation: mis-obeyed priority / turning, etc.
g) Types of speed limitation: local limit / traffic sign, etc.
h) Maximum permitted speed: 30 km/h, 50 km/h etc.
i) Speed limit and distribution
j) Speed before the accident and at the time of collision
k) View obstruction
l) Used lane when encountering an accident
m) Road surface: asphalt / cobble stone / sand, etc.
n) Precipitation at the time of the accident
o) Road condition: dry / wet / snow, etc.
p) Cloudiness at the time of the accident

Selecting and combining the use cases for analysis

Within the selected accident types, there exist more precise accident types as shown in Figure 2 and Figure 3 for crossing traffic accidents. Accident type 302 which counts for 38% (n=2,014) of all the crossing traffic accident types was already studied. The rest of the top 5 accident types of crossing traffic, i.e. 321, 301, 303 and 322 are analysed here. Due to their similarity, accident types 301 and 303 (n=1.149) and accident types 321 and 322 (n=1.148) were respectively combined and analysed together.

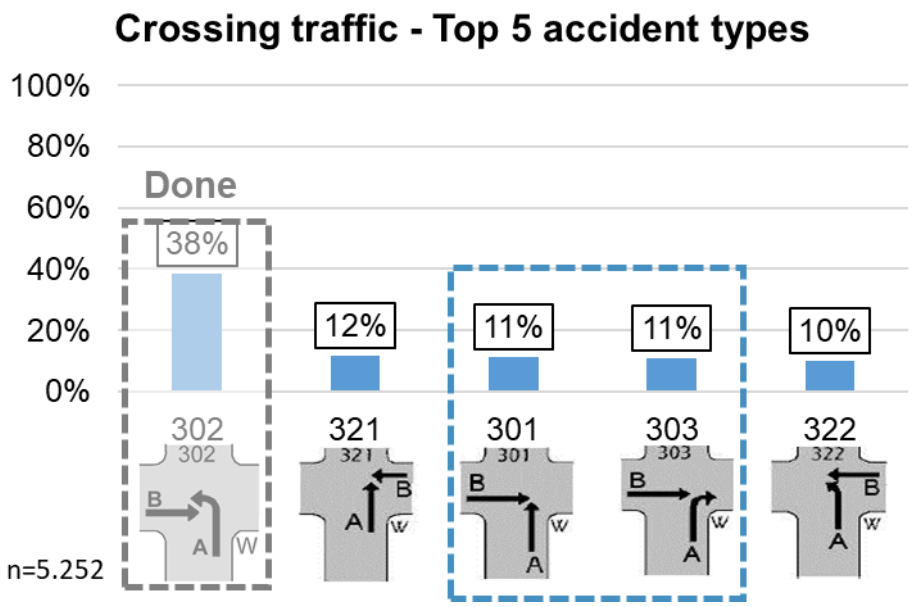

Figure 2: Selection and combination of crossing traffic accident type 301 & 303

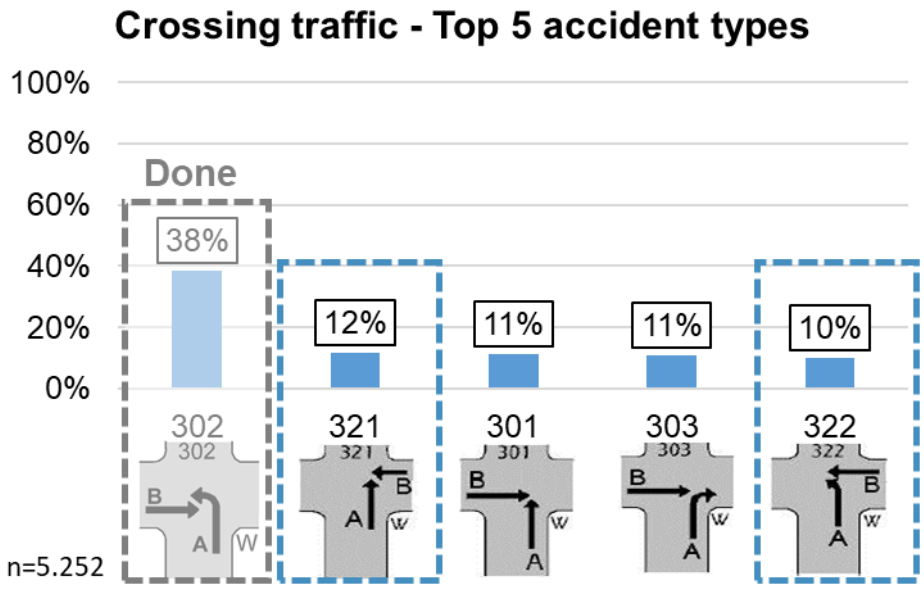

Figure 3: Selection and combination of crossing traffic accident type 321 & 322

3. Use case description

3.1.1 Crossing traffic accident types 301 & 303

The crossing traffic accident types 301 & 303 describe a conflict between a road user (Participant A) who is obligated to wait ("W" in the figure), and a road user (Participant B) entitled to the right of way (Figure 4).
At the crossing traffic accident type 301, Participant A wants to go straight. On the other hand, at the crossing traffic accident type 303, Participant A wants to turn right. Participant B is approaching the crossing from the left-hand side as seen from Participant A.
It does not matter whether the waiting Participant A is obliged to wait by traffic signs (e.g., STOP sign, GIVE WAY sign) or not. The accident types 301 & 303 may occur at crossings of roads and junctions, roundabouts as well as property exits. Roundabouts are a distinctive accident scene of accident types 301 & 303. Accidents at roundabouts basically do not occur with accidents type 321 & 322 and 302 (5.1.2). Later on in this document, accidents at roundabouts are compared to other accidents specifically (5.2).

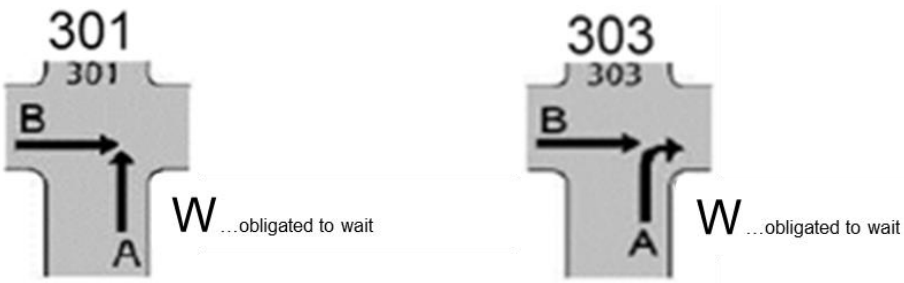

Figure 4: Crossing traffic accident types 301 & 303

3.1.2 Crossing traffic accident types 321 & 322

The crossing traffic accident types 321 & 322 describe a conflict between a road user (Participant A) who is obligated to wait ("W" in the figure), and a road user (Participant B) entitled to the right of way (Figure 5).
At the crossing traffic accident type 321, Participant A wants to go straight. On the other hand, at the crossing traffic accident type 322, Participant A wants to turn left. Participant B is approaching the crossing from the right-hand side as seen from Participant A.
It does not matter whether the waiting Participant A is obliged to wait by traffic signs (e.g., STOP sign, GIVE WAY sign) or not. The accident types 321 & 322 may occur at crossings of roads and junctions as well as property exits.

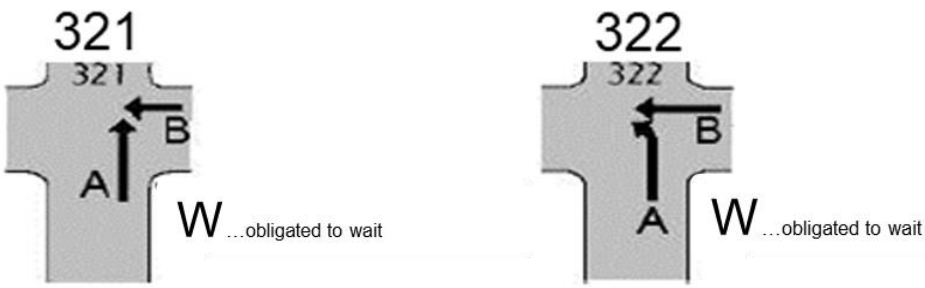

Figure 5: Crossing traffic accident types 321 and 322

4. Summary of the Analysis Results

In this chapter, a summary of the analysis results of each accident type is provided. Detailed analysis results can be found in Chapter 5.

4.1 Crossing traffic accident types 301 & 303, 321 & 322 and 302

Main findings.

- The accident scene of accident types 301 & 303 was primarily at crossings, followed in order by junctions, roundabouts and property exits. For accident types 321 & 322 the order was: crossings, junctions and property exit. For accident type 302 it was junctions, crossings and property exit. Roundabouts are a distinctive accident scene of accident types 303. (5.1.2)
- In most cases, Participant A are M1 / N1 vehicles (passenger cars / light commercial vehicles) and Participant B is a PTW. This is particularly prominent in 302. The main accident causer is Participant A and only in a rare number of cases it is Participant B. (5.1.4 , 5.1.5)
- Comparing the initial speed of Participant A and the collision speed, Participant A is found to slowly start and collide with a slightly higher speed. Therefore Participant A is accelerating slightly between start and collision. Participant B starts from 45 km/h (301 & 303), 45 km/h (321 & 322) and 50 km/h (302) initially and decelerates to 35 km/h, 34 km/h and 38 km/h in the median scenario. This could be interpreted in a way that Participant B has recognised Participant A blocking its way and consequently starts decelerating. (5.1.10)
- In approx. 70% of the cases no view obstruction was present. The remaining cases involved permanent view obstruction such as buildings, and non-permanent obstruction such as moving and parked cars. (5.1.11).
- Weather condition is not a major factor for the accidents. (5.1.13 to 5.1.16)
- In 91% of accidents in roundabouts people are slightly injured and only in 9% people are seriously injured. This is a lower proportion of seriously injured than in all accidents of the combination 301 & 303. (5.2.1)
- In roundabouts, as compared to all accidents of the combination 301 & 303, the initial speed of Participant A is 12 km/h higher, the initial speed of Participant B is 15 km/h lower, the collision speed of Participant A is 4 km/h lower and the collision speed of Participant B is 10 km/h lower. (5.2.2)

5. Crossing traffic accident analysis

In this chapter, the details of the crossing traffic accident analysis results about 301 & 303 and 321 & 322 are shown. The result of 302 is shown as reference, additionally.

5.1 Analysis results

5.1.1 a) Location of the accident

The majority of PTW accidents for crossing traffic occurred on urban roads which account for 73.4% of overall 301 & 303 types (Figure 6), 74.7% of overall 321 & 322 types (Figure 7), and 67.3% of overall 302 type (Figure 8). This could be understood from the fact that in an urban area, more traffic participants exist and more crossing roads exist, all making it more a frequent situation.

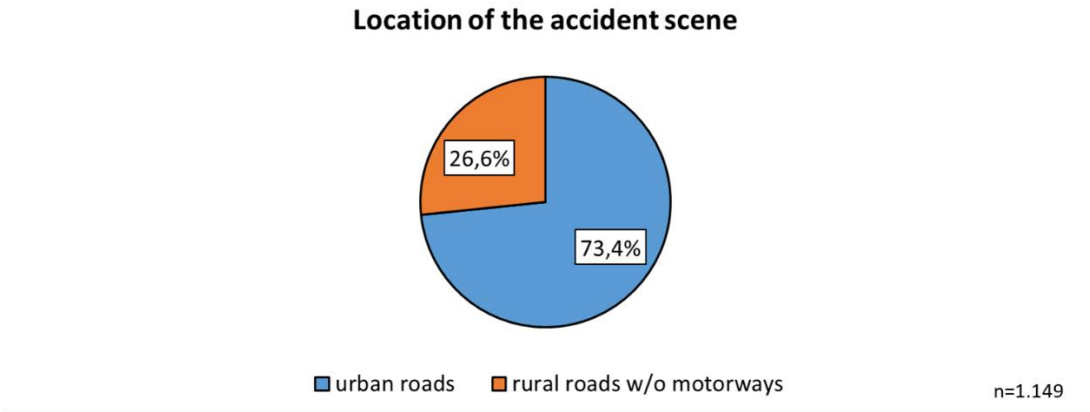

Figure 6: Location of the accident (301 & 303)

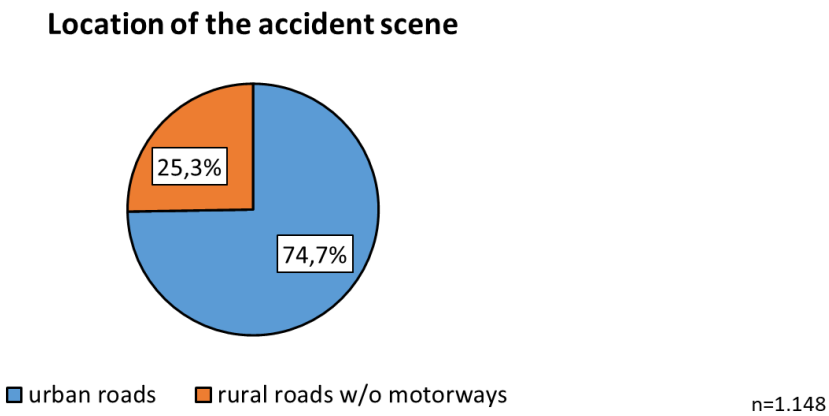

Figure 7: Location of the accident (321 & 322)

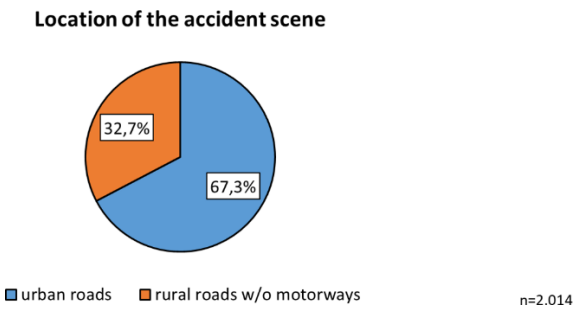

Figure 8: Location of the accident (302)

5.1.2 b) Accident scene

There is a difference of accident scene ratio between 301 & 303, 321 & 322 and 302.
At the accident types 301 & 303, the first accident scene is at crossings which accounts for 43.4%, the second is at junctions (23.8%), the third is at roundabouts (15.2%) and the fourth is at property exits (14.4%) (Figure 9). Roundabouts are a distinctive accident scene of accident types 301 & 303.
At the accident types 321 & 322, the first accident scene is at crossings which accounts for 66.1%, the second is at junctions (25.2%), the third is at property exits (5.6%) (Figure 10). The accident types 321 & 322 are characterised by high ratio at crossings.
At the accident type 302, the first accident scene is at junctions which accounts for 53.2%, the second is at crossings (29.5%), the third is at property exits (16.1%) (Figure 11). The accident type 302 is characterised by a high ratio at junctions.
It is commonly understood that PTWs, being small in size, are often misjudged by car drivers regarding their speed and distance. In the frame of the MAIDS project (Motorcycle In-Depth Accident Study), in-depth analyses of 921 accidents from five sampling areas across Europe involving PTWs were conducted (ACEM, 2009[1]). Focusing on the other vehicle involved, traffic-scan error was present and contributed to accident causation in 62.9 % of the analysed data. In a further 18.4 %, an attention failure including distraction and stress was observed. Therefore, to properly time the entry into these crossings, junctions and roundabouts is a challenge for car drivers.

[1] ACEM (2009), MAIDS Final report 2.0, available online https://www.maids-study.eu/pdf/MAIDS2.pdf (last access November 19th 2021).

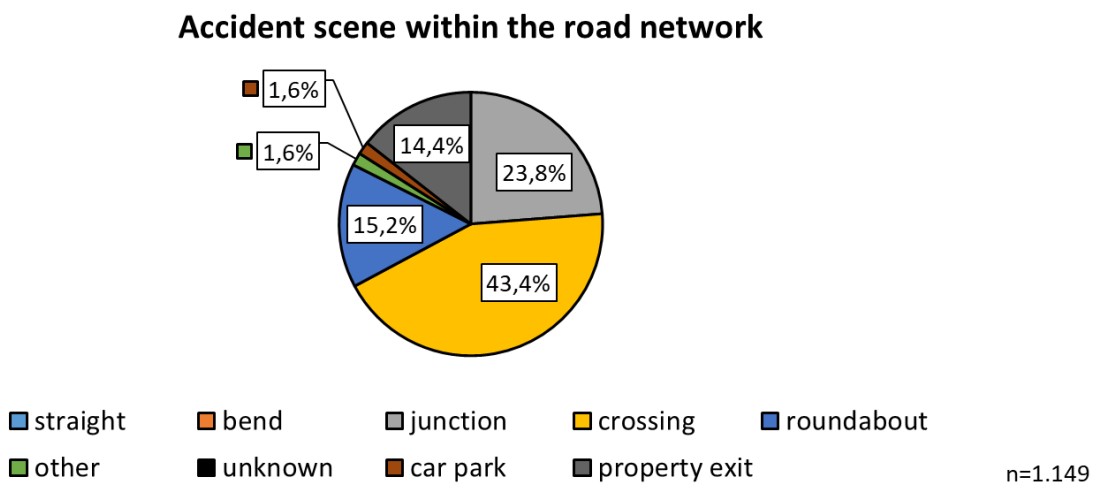

Figure 9: Accident scene (301 & 303)

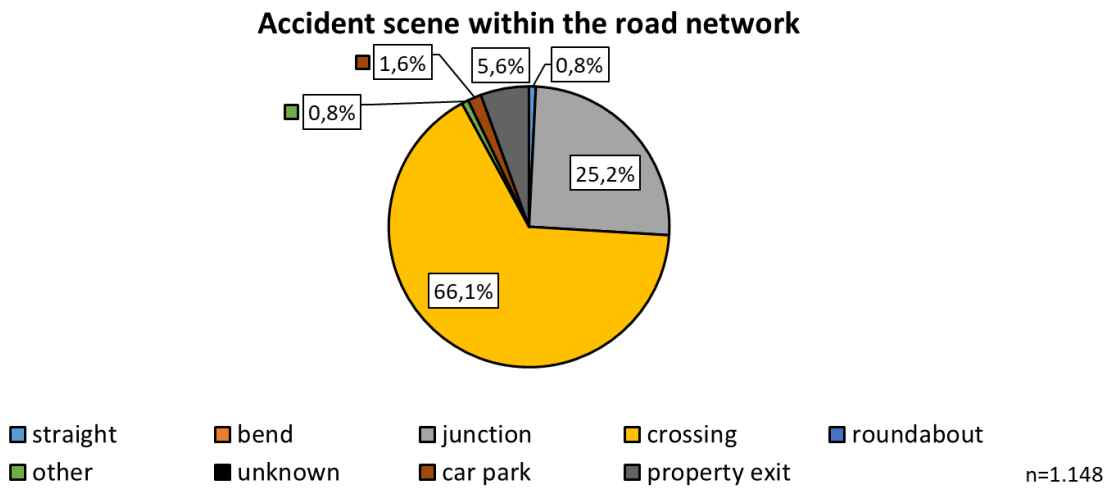

Figure 10: Accident scene (321 & 322)

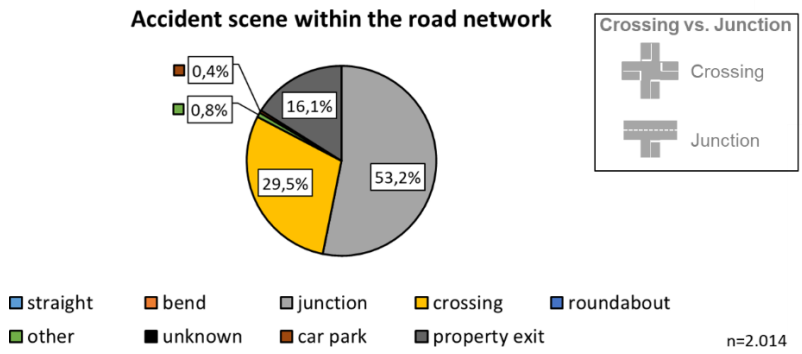

Figure 11: Accident scene (302)

5.1.3 c) Kind of traffic regulation

Right-of-way regulation was the predominant traffic regulation at the accident site involving PTWs. This was common for all accident types 301 & 303, 321 & 322 and 302. As mentioned in 5.1.2 , the PTW being small in size is often misjudged and even if Participant A intended to

follow the rule of right of way, it could be that the timing for Participant A to enter the crossing / junction / roundabout may have been improper due to a misjudgement of the PTW's speed and distance.

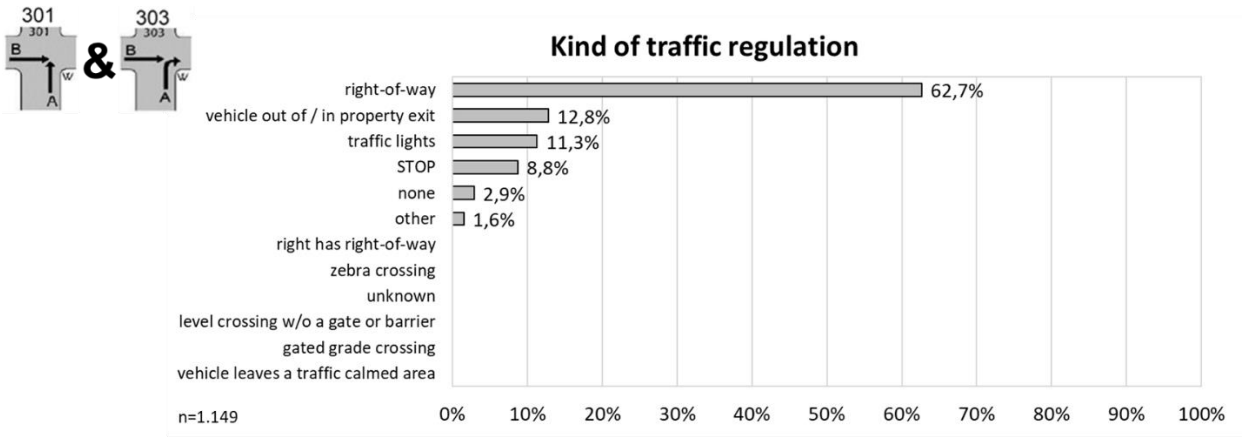

Figure 12: Kind of traffic regulation (301 & 303)

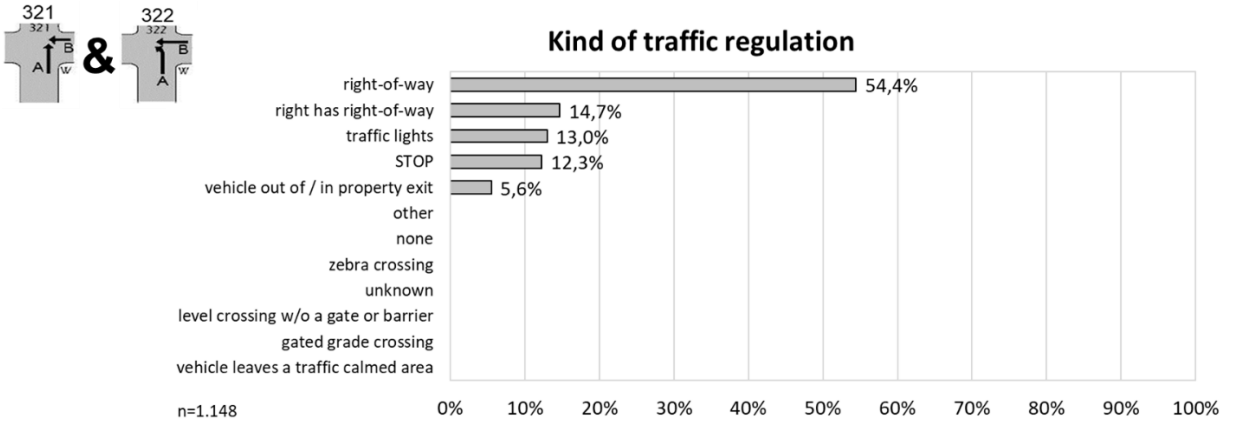

Figure 13: Kind of traffic regulation (321 & 322)

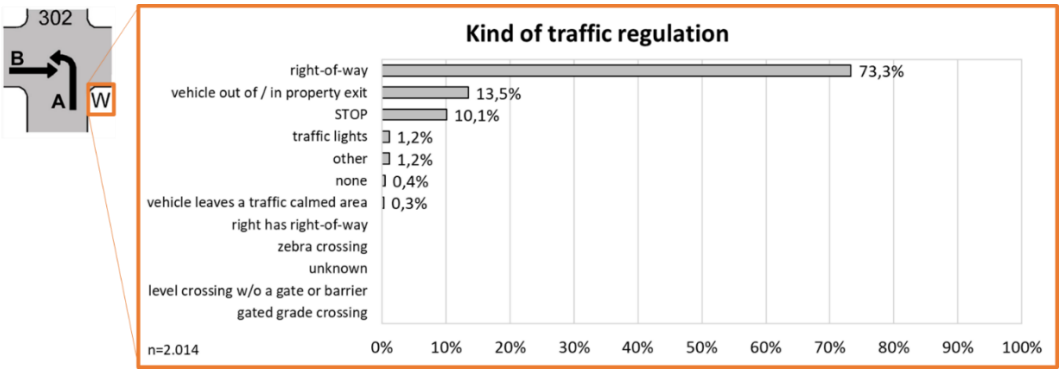

Figure 14: Kind of traffic regulation (302)

5.1.4 d) Kind of road user

Traffic participants in crossing traffic accidents involving a PTW, are shown in Figure 15, Figure 16 and Figure 17. Even though the percentages at accident types 301 & 303 and 321 & 322

are not as high a percentage as at 302, still in over 80% of cases, Participant A is an M1 / N1 vehicle (passenger car / light commercial vehicle) and Participant B is a motorcycle (PTW).

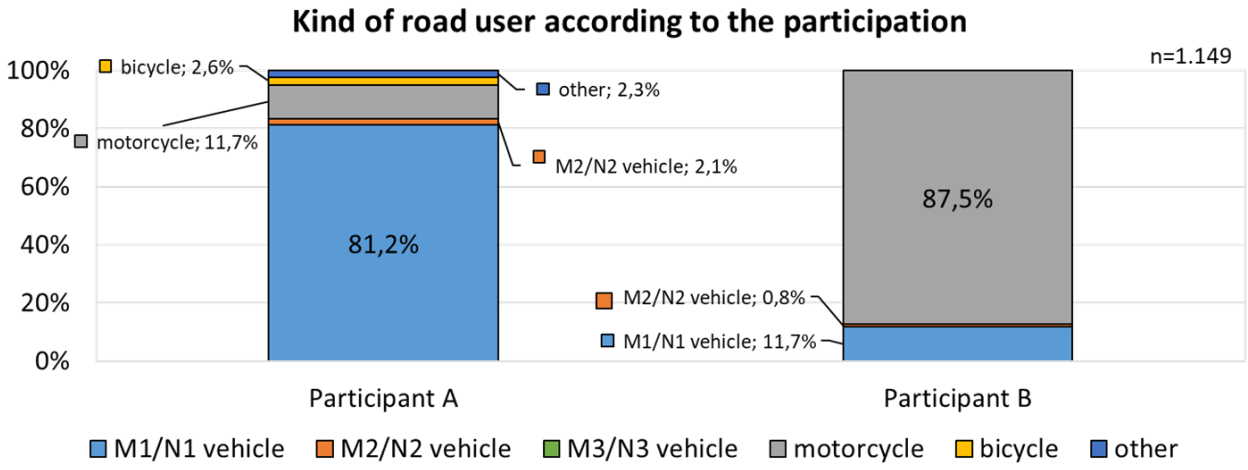

Figure 15: Kind of road user (301 & 303)

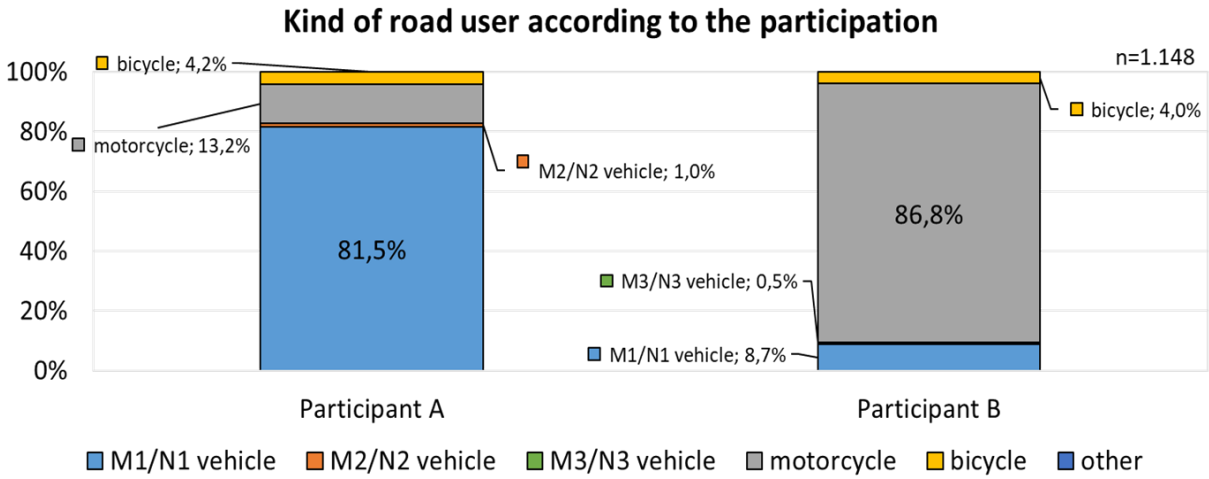

Figure 16: Kind of road user (321 & 322)

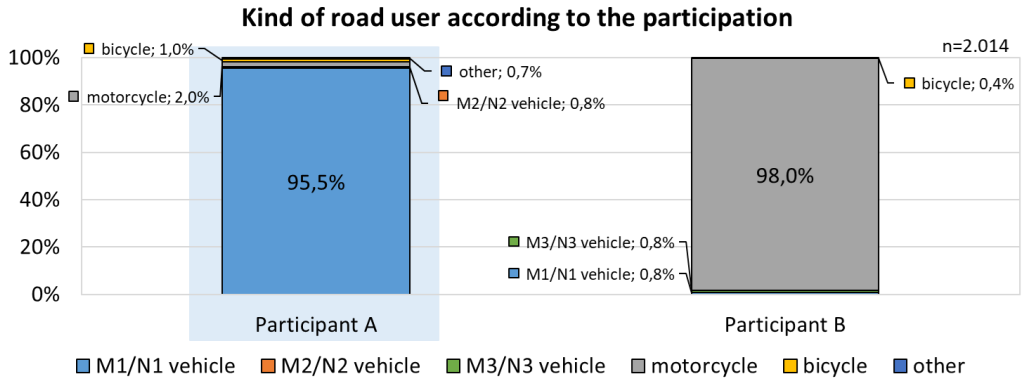

Figure 17: Kind of road user (302)

5.1.5 e) Main accident causer

The main accident causer in crossing traffic accidents is shown in Figure 18, Figure 19 and Figure 20. It is clear from these figures that the main accident causer is Participant A and only in a rare number of cases it is Participant B.

The whole range of Figure 15 to Figure 20 indicates that there is a strong need to address car driver's driving behaviour in order to mitigate PTW accidents in crossing traffic accident situations.

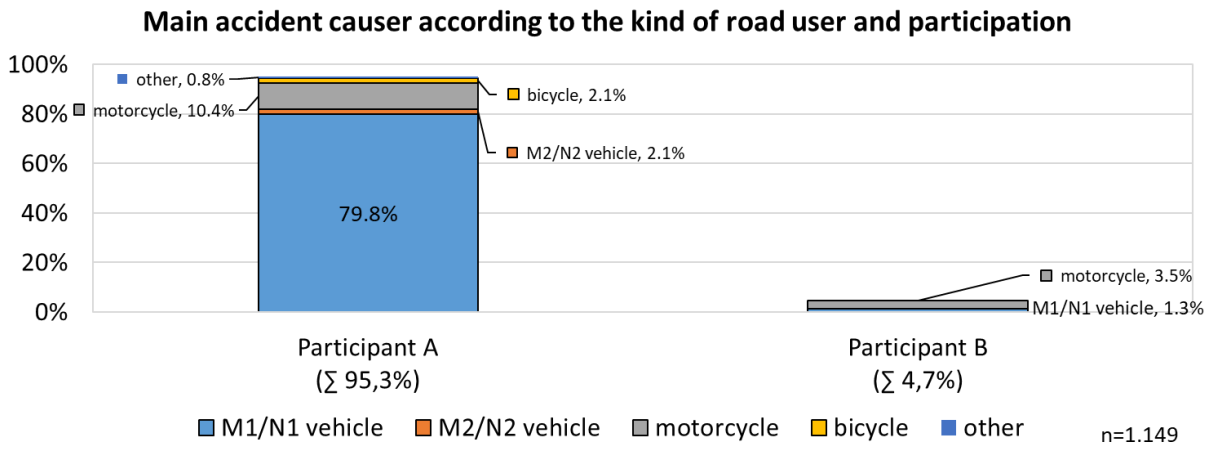

Figure 18: Main accident causer (301 & 303)

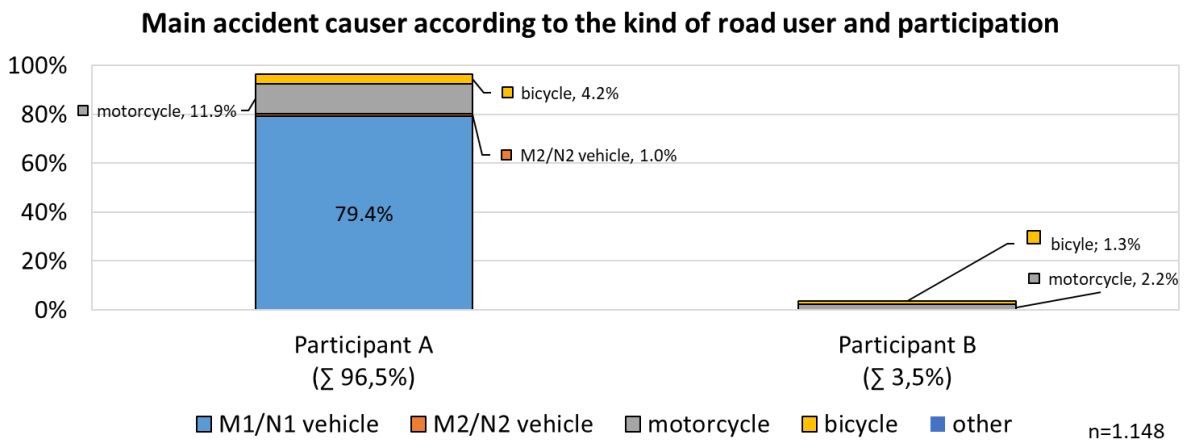

Figure 19: Main accident causer (321 & 322)

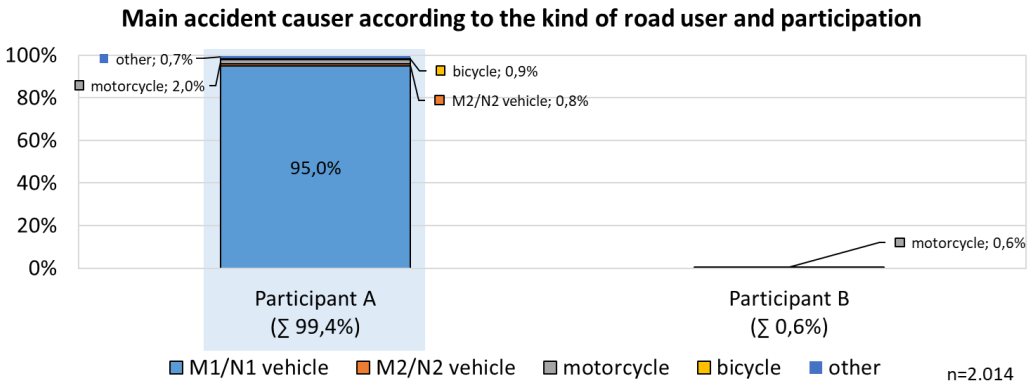

Figure 20: Main accident causer (302)

5.1.6 f) Main accident causation

The main causation of the accidents is studied and shown in Figure 21 to Figure 23. From these figures, it is understood that the main reason for the accident was failure of Participant A to respect priority. However, there also occurred failures of Participant B, although only few.

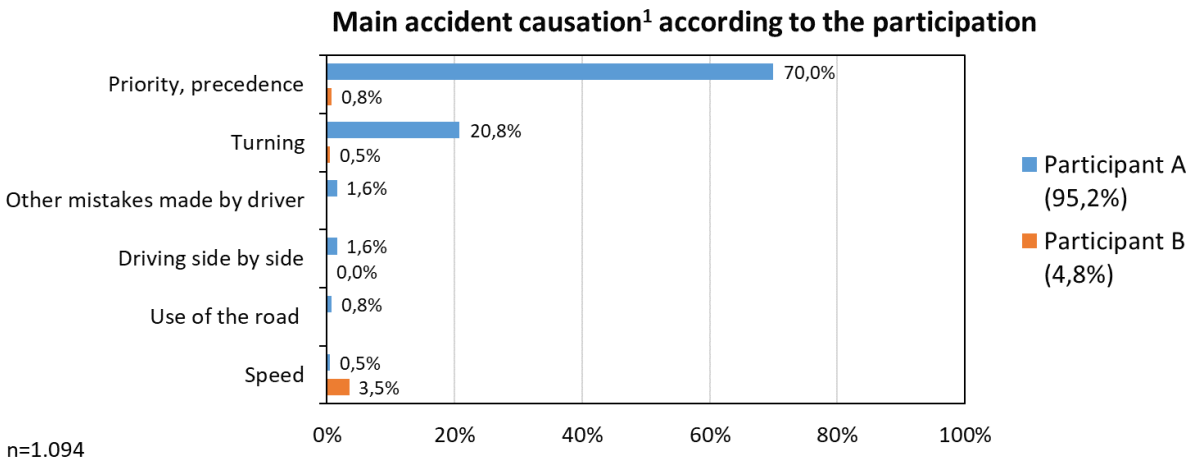

Figure 21: Main accident causation (301 & 303)

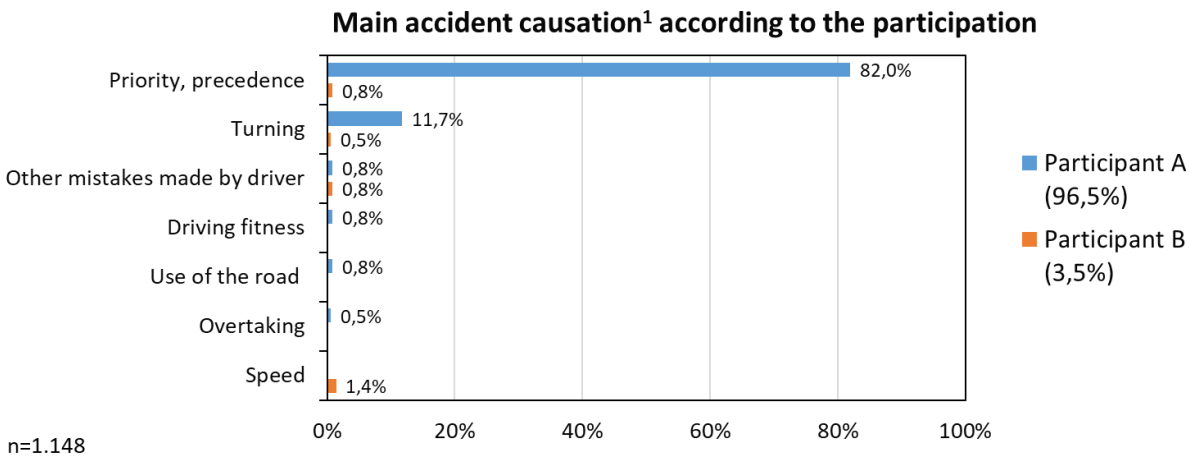

Figure 22: Main accident causation (321 & 322)

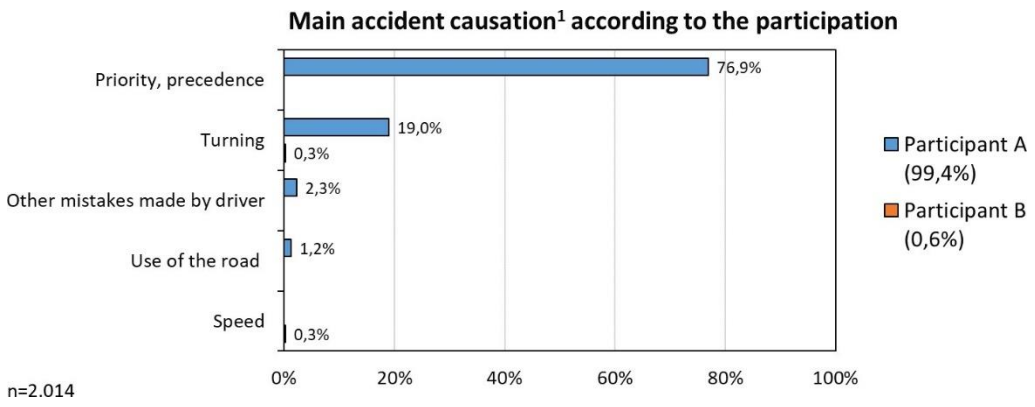

Figure 23: Main accident causation (302)

1: The police and also the technical investigation units in GIDAS have to assign a main accident causer with one main accident causation in each accident.

The accident causation by participant is shown in Figure 24 to Figure 26. The accident causation of Participant B, it was mainly “Speed”.

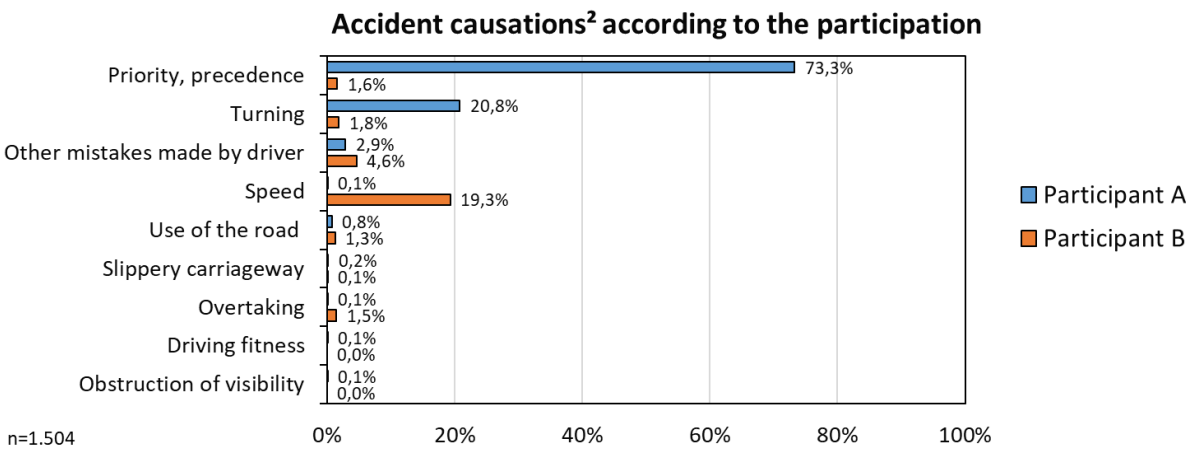

Figure 24: Accident causations (301 & 303)

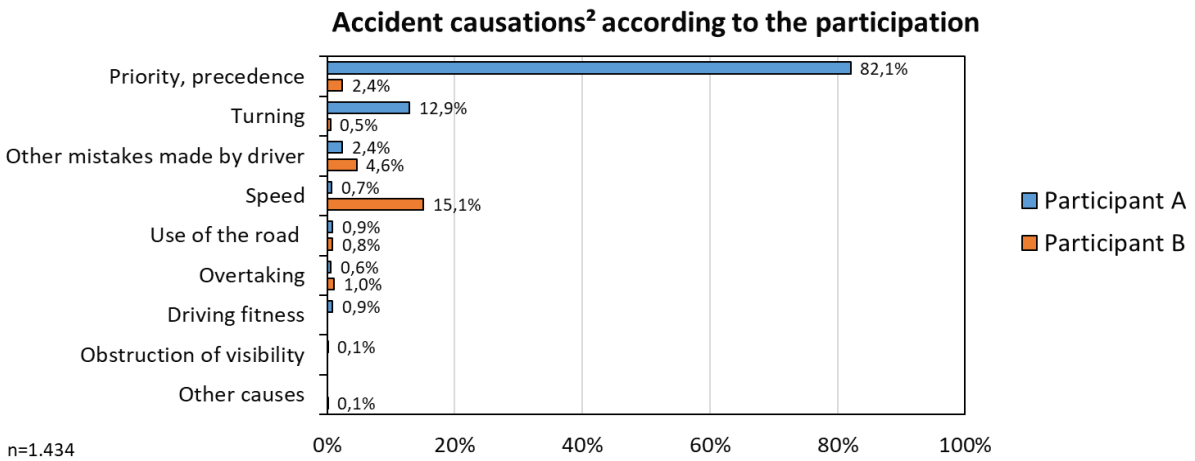

Figure 25: Accident causations (321 & 322)

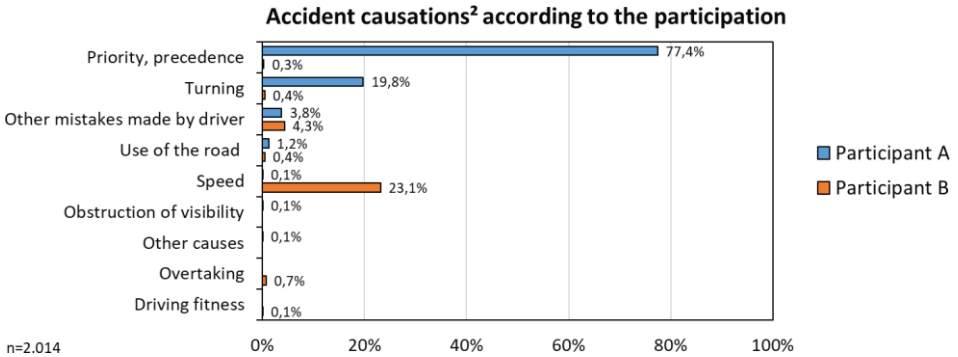

Figure 26: Accident causations (302)

2: The police and the technical investigation units in GIDAS can assign up to 3 accident causations for each accident participant. Consequently, one accident can have several accident causes depending on the participant and so the sum of the accident causations is ≥100%.

5.1.7 g) Types of speed limitation

What provides the speed limit to each participant is shown in Figure 27 to Figure 29. Both for Participant A and B, the majority of speed limits are provided by local traffic rules and secondly by traffic signs.

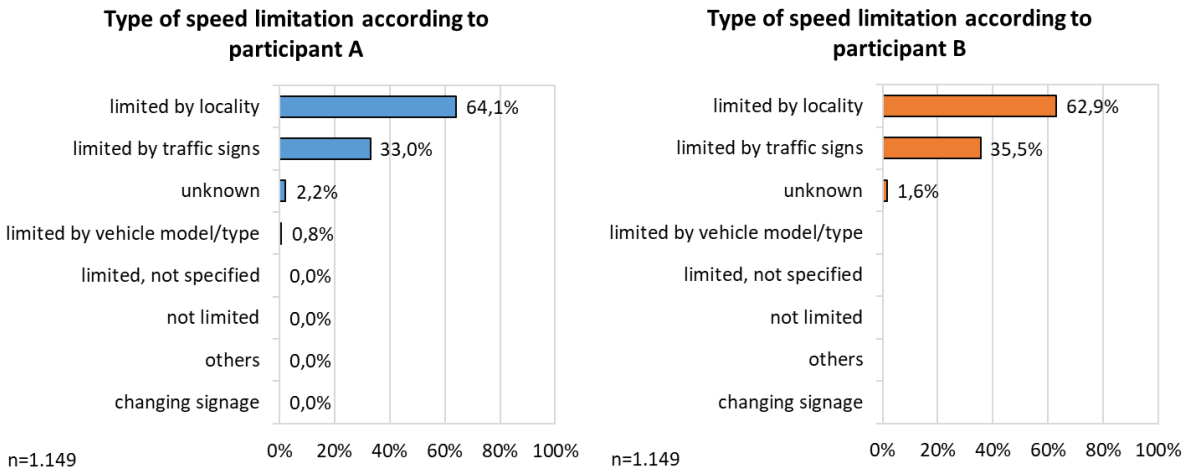

Figure 27: Types of speed limitation for the participants (301 & 303)

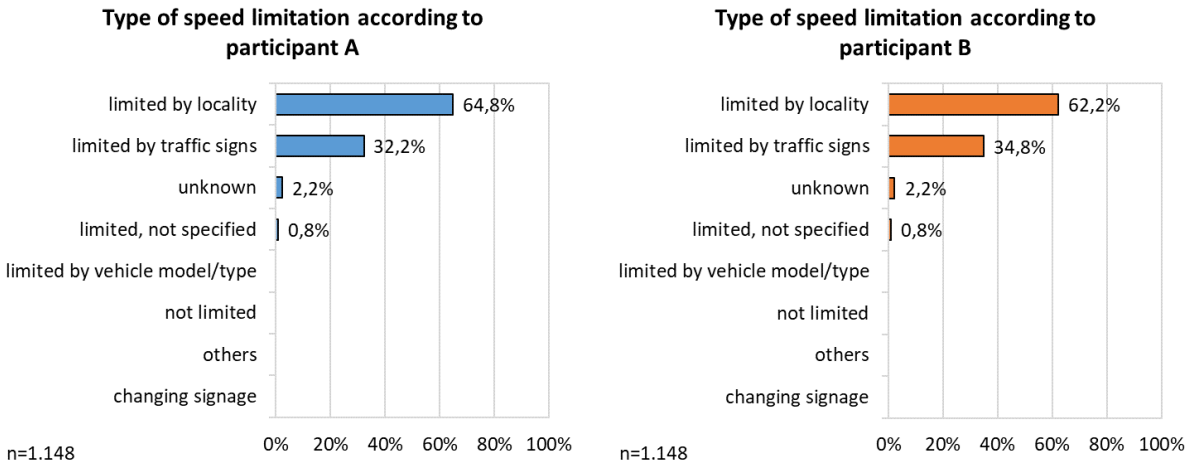

Figure 28: Types of speed limitation for the participants (321 & 322)

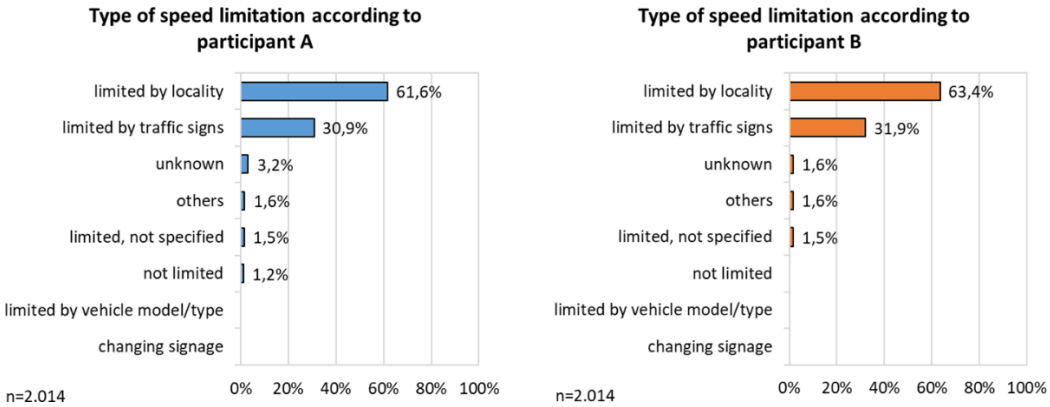

Figure 29: Types of speed limitation for the participants (302)

5.1.8 h) Maximum permitted speed

Maximum permitted speed on the accident site is shown in Figure 30 to Figure 32. As seen in Figure 6, Figure 7 and Figure 8 2/3 of accidents took place at urban roads. Therefore it is in line with expectations to see that the most frequent maximum permitted speed is 50 km/h. However, as Participant B has the right of way, a slightly higher maximum permitted speed can be observed for Participant B.

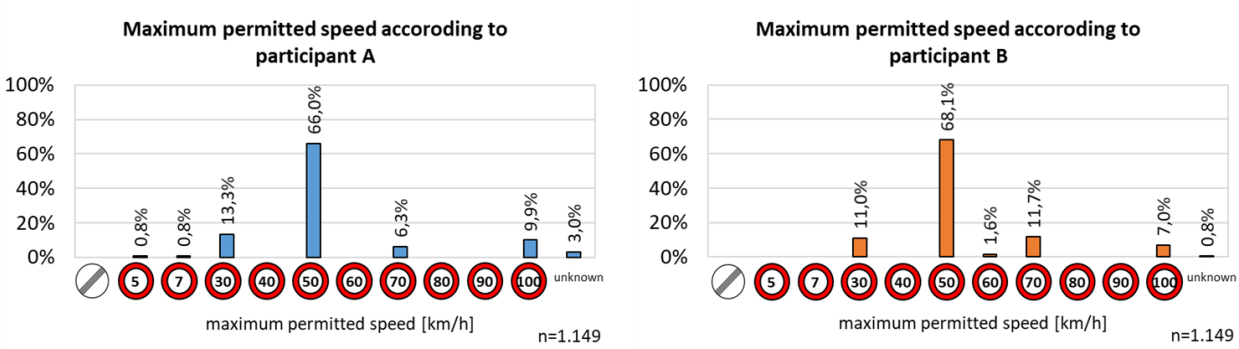

Figure 30: Maximum permitted speed (301 & 303)

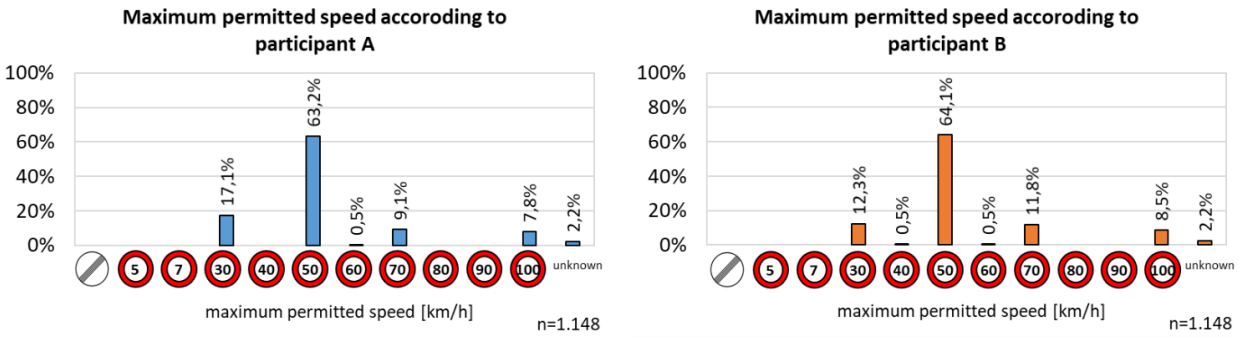

Figure 31: Maximum permitted speed (321 & 322)

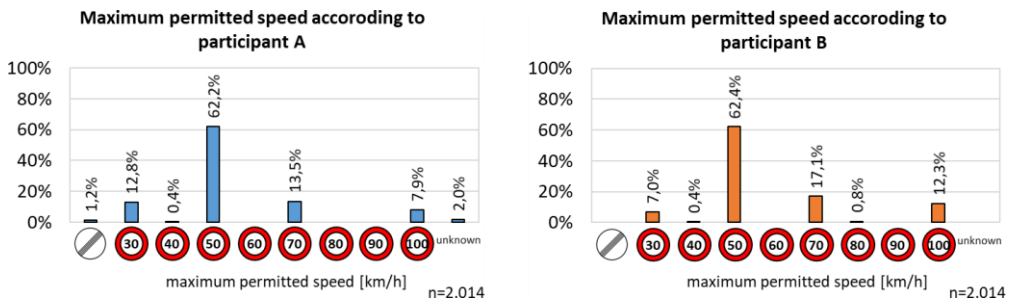

Figure 32: Maximum permitted speed (302)

5.1.9 i) Speed limit and distribution

The percentage of participants exceeding the applicable speed limit is shown in Figure 33 to Figure 35. Comparing Participants A and B, it can be observed that Participant B is more often seen to have exceeded the speed limit. This could be understood from the crossing traffic accident type that Participant A starts its action by waiting and then to turn while Participant B is to go straight passing through.

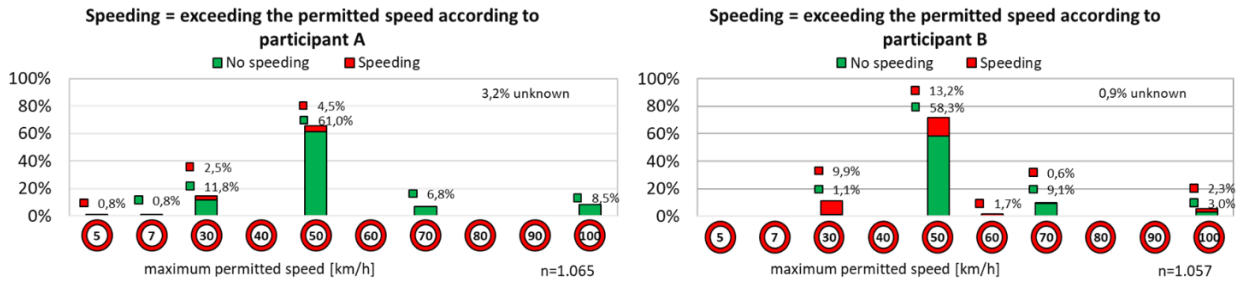

Figure 33: Exceeding Speed limit (301 & 303)

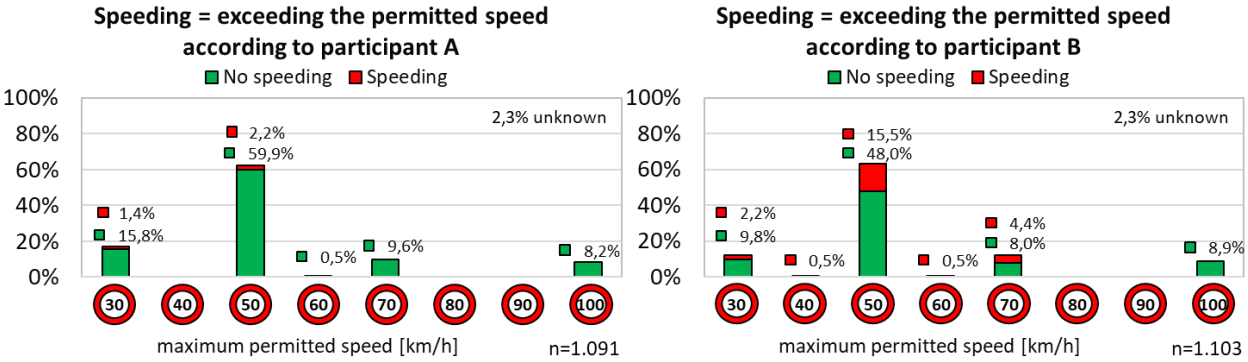

Figure 34: Exceeding Speed limit (321 & 322)

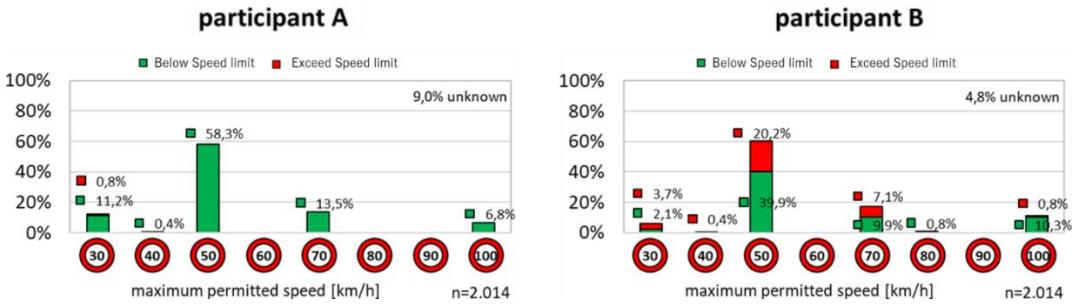

Figure 35: Exceeding Speed limit (302)

The distribution of how much Participant B exceeded the allowable speed for each given speed limit before reaching the point of incident is shown in Figure 36 to Figure 38. Though Participant B in the crossing traffic accident scenario has the right of way, in some cases, exceeding the speed limit could be one of the influencing factors for Participant B.

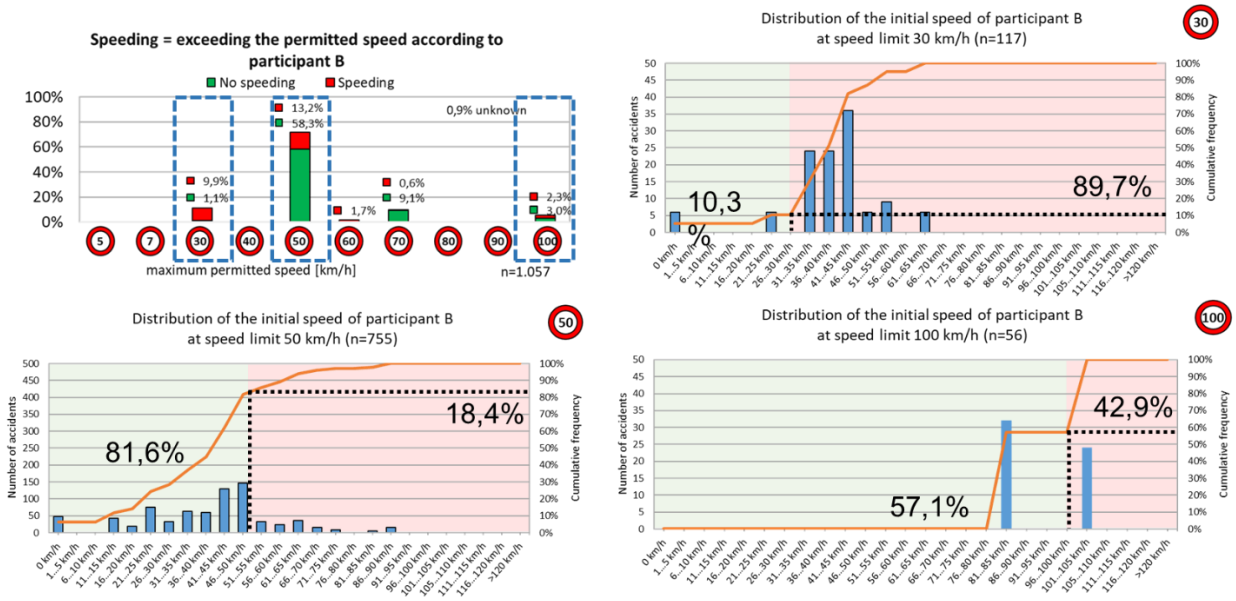

Figure 36: Speed distribution by Participant B (301 & 303)

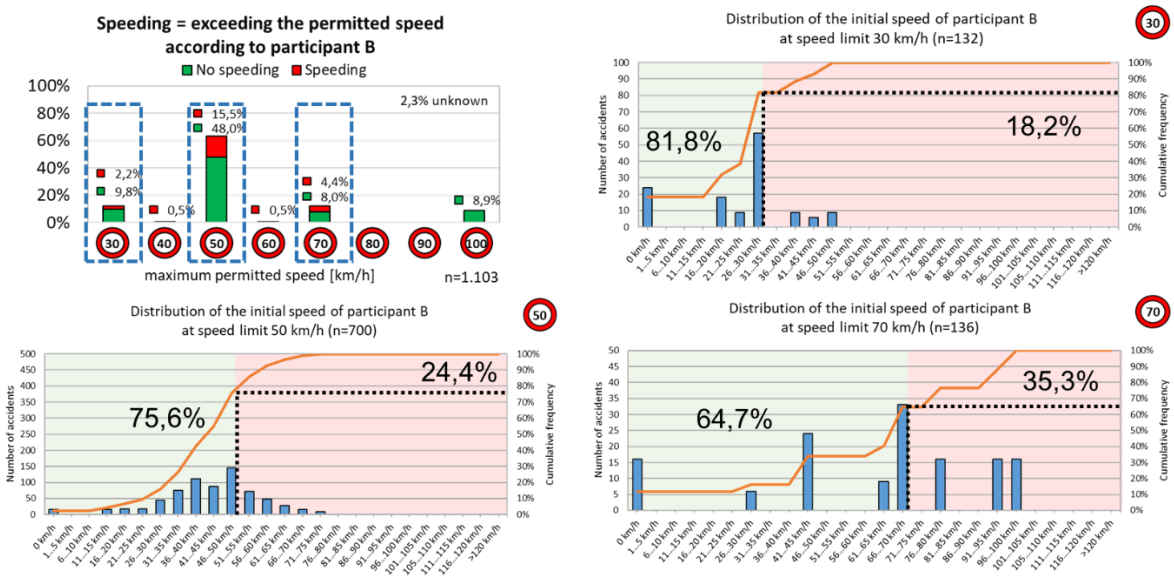

Figure 37: Speed distribution by Participant B (321 & 322)

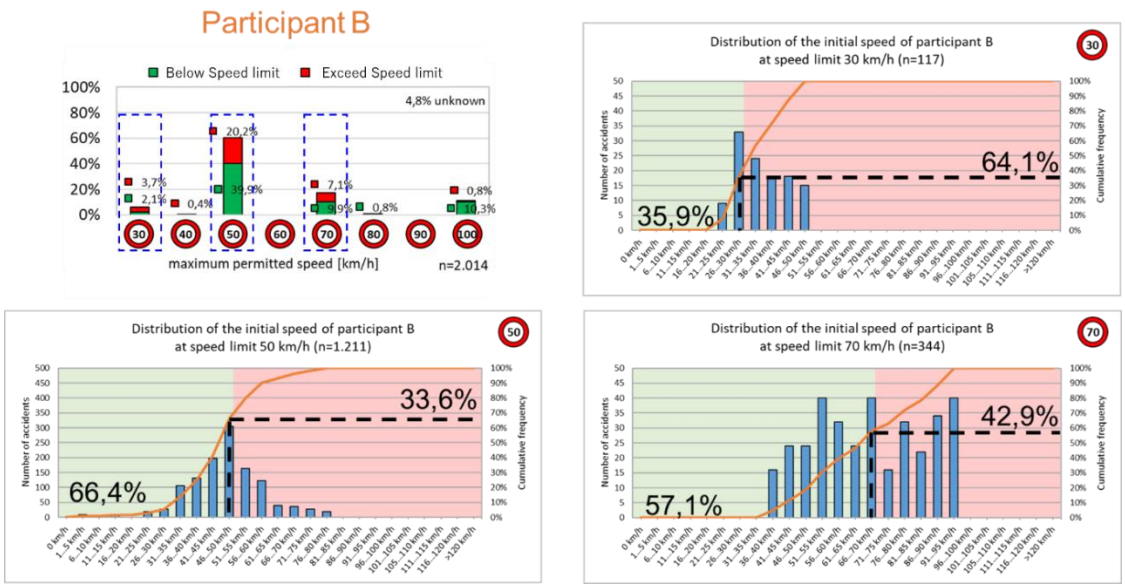

Figure 38: Speed distribution by Participant B (302)

5.1.10 j) Speed before the accident and at the time of collision

The initial speed of each participant is shown in Figure 39 to Figure 41. It is clear from these figures that Participant B going straight has higher average speed than Participant A who waits to start the turning process.

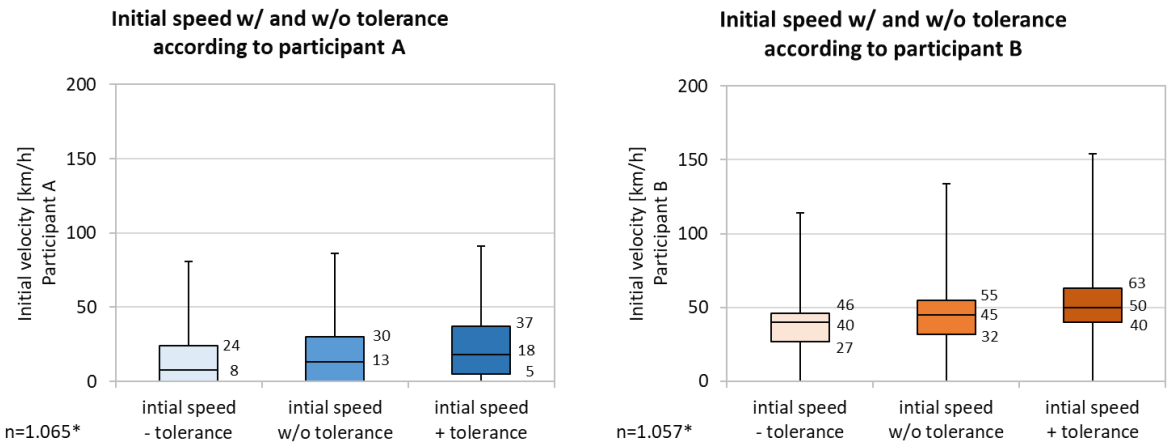

Figure 39: Initial speed of participants (301 & 303)

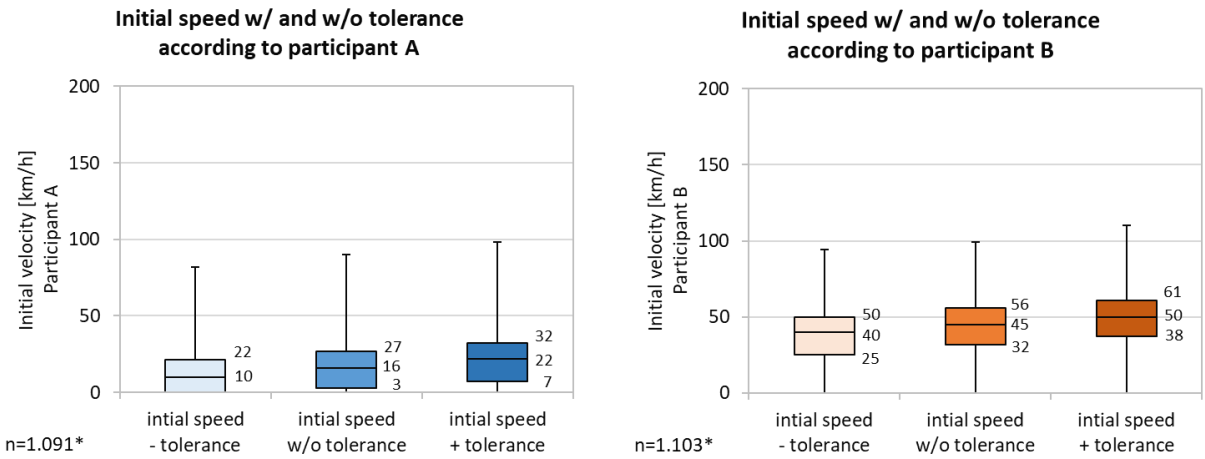

Figure 40: Initial speed of participants (321 & 322)

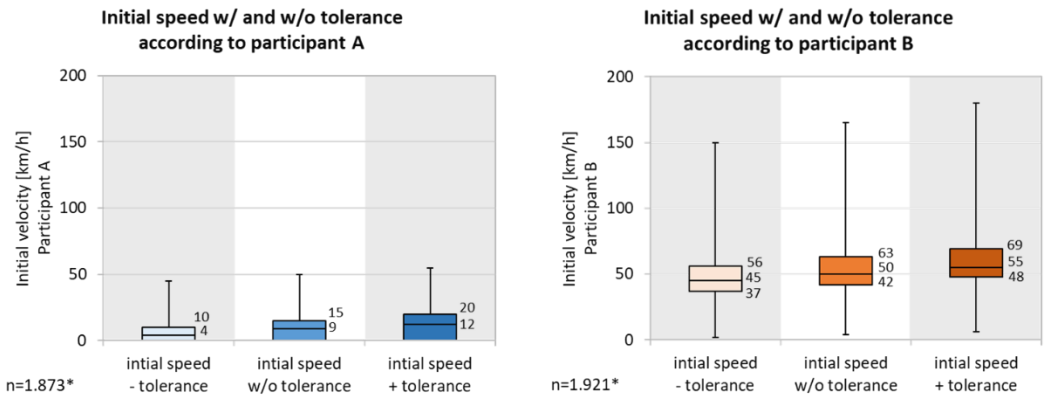

Figure 41: Initial speed of participants (302)

The collision speed of each participant is shown in Figure 42 to Figure 44. Comparing the initial speed of Participant A and the collision speed, Participant A is found to slowly start and collide with a slightly higher speed. This could indicate that Participant A was waiting for a chance to start the process but missed its timing or overlooked the PTW and collided.

Looking at Participant B, comparing the initial speed and the collision speed, it is seen that it starts respectively from 45 km/h, 45 km/h and 50 km/h initially and decelerates to 35 km/h, 34 km/h and 38 km/h in the median scenario. This could be interpreted in a way that Participant B has recognised Participant A blocking its way and consequently starts decelerating.

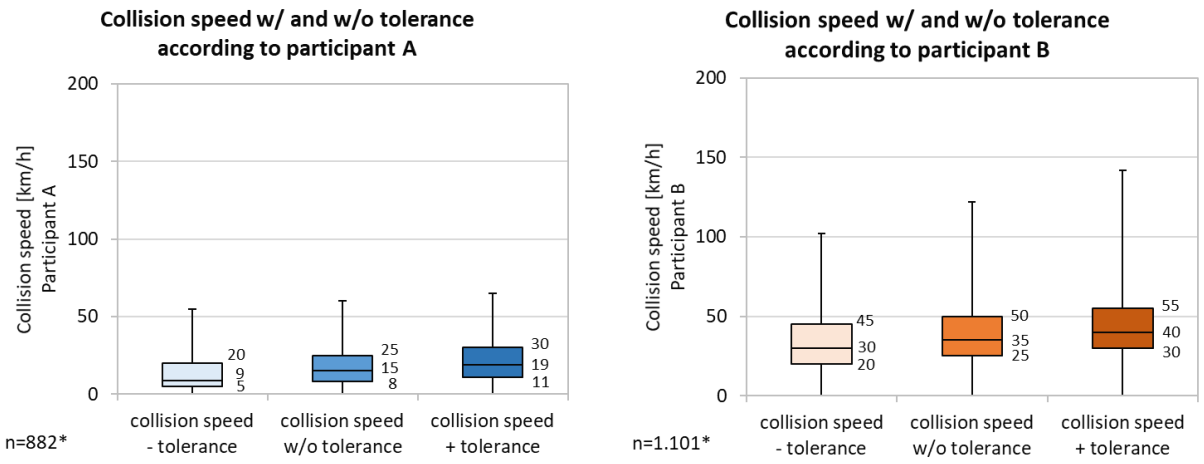

Figure 42: Collision speed of participants (301 & 303)

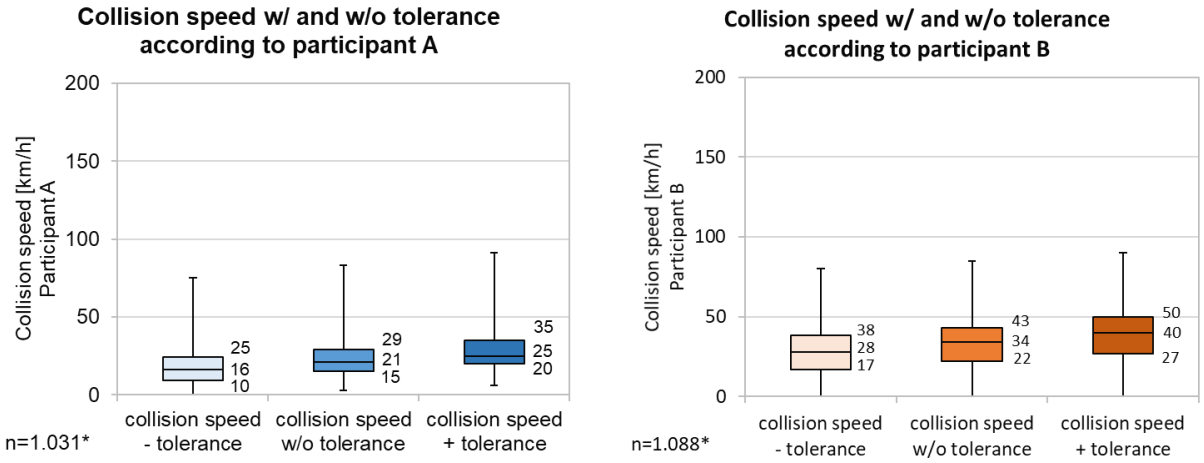

Figure 43: Collision speed of participants (321 & 322)

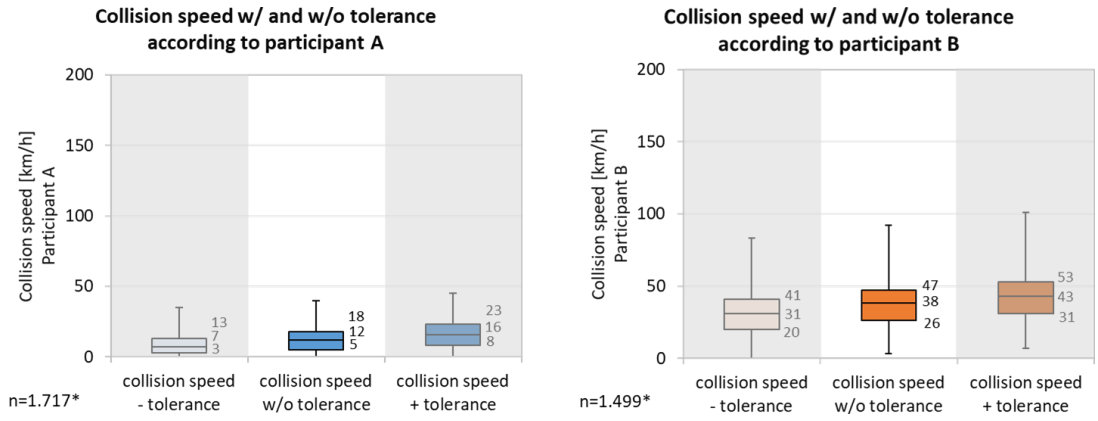

Figure 44: Collision speed of participants (302)

5.1.11 k) View obstruction

Figure 45 to Figure 47 shows the existence of view obstructions. Figure 48 to Figure 50 show the types of obstruction. It can be seen that in approx. 70% of the cases no view obstruction

occurred.The remaining cases involved permanent view obstruction such as buildings, and non-permanent obstruction such as moving and parked cars.

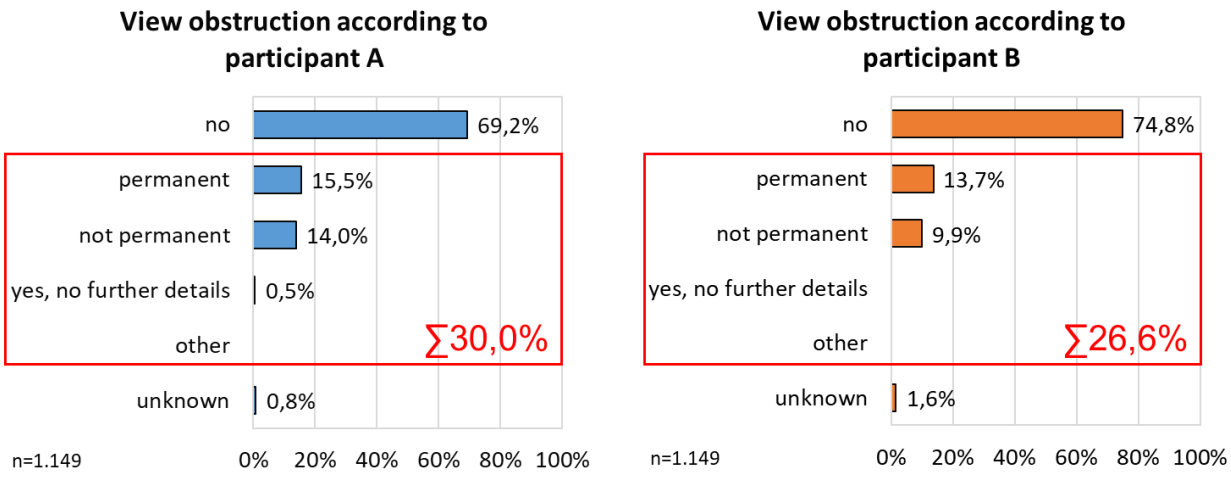

Figure 45: View obstruction (301 & 303)

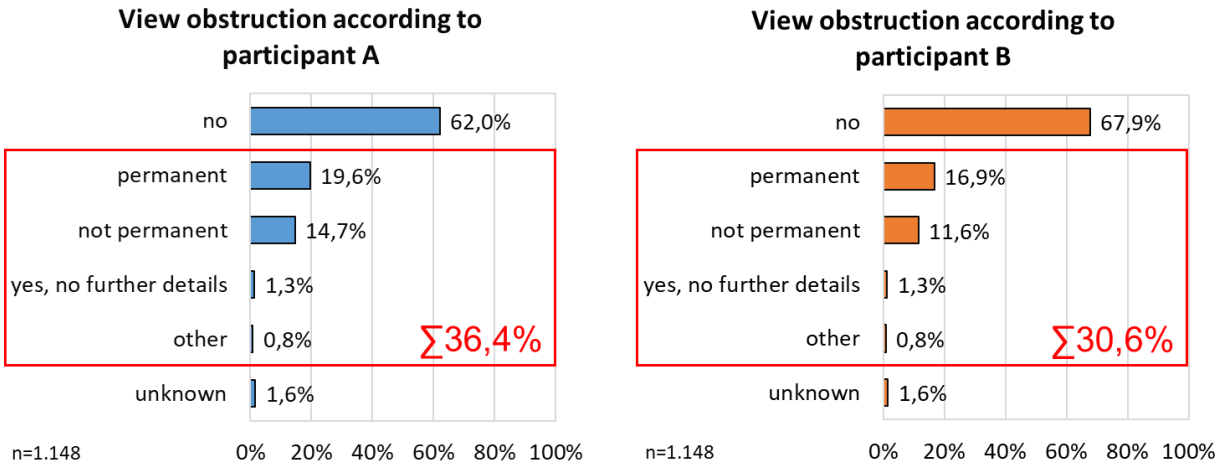

Figure 46: View obstruction (321 & 322)

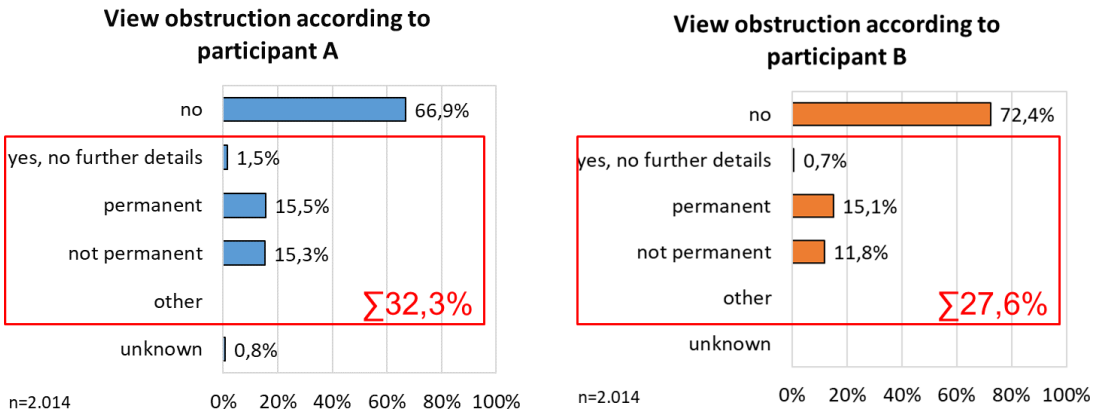

Figure 47: View obstruction (302)

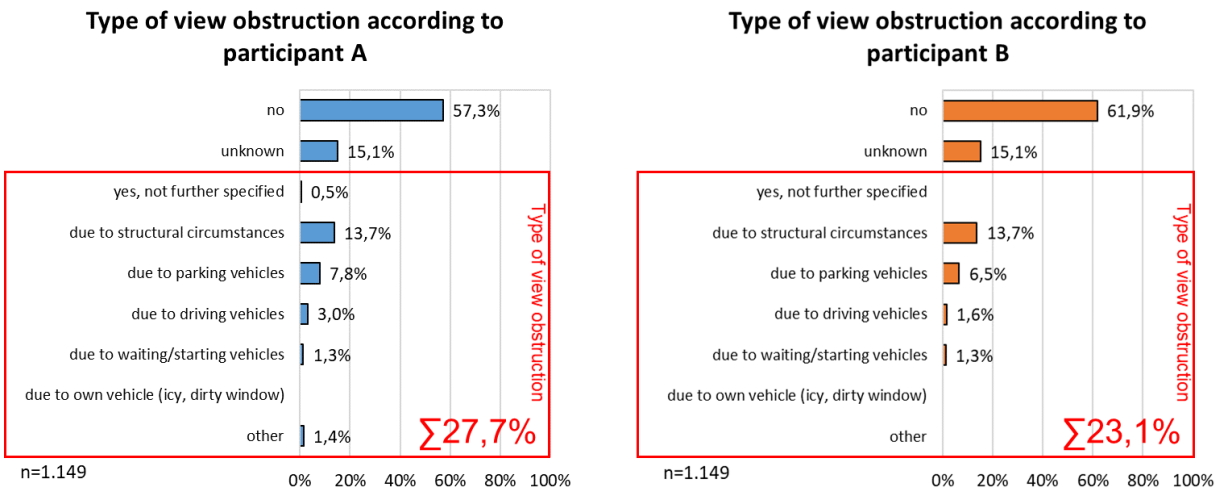

Figure 48: Type of view obstruction (301 & 303)

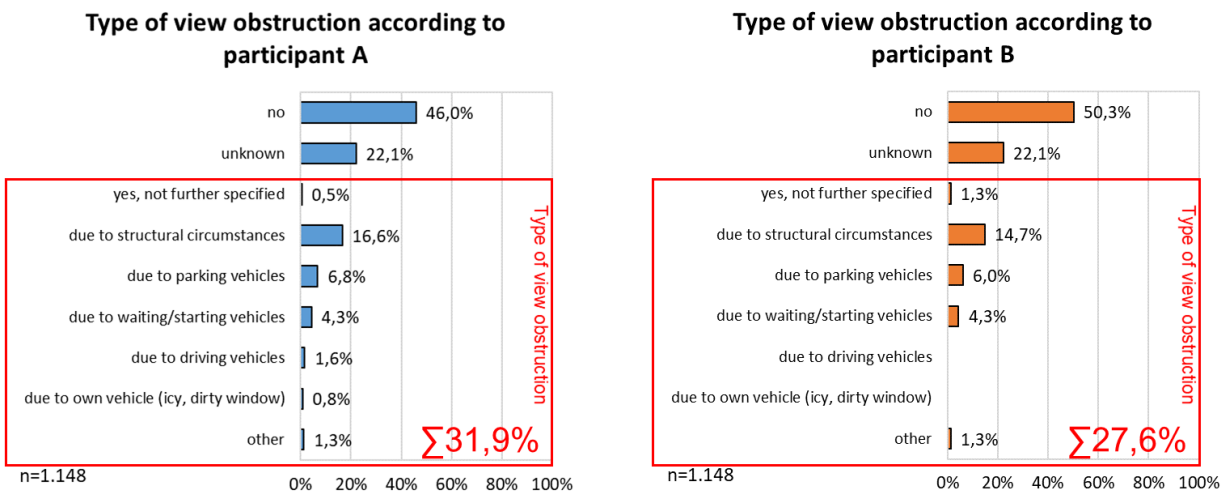

Figure 49: Type of view obstruction (321 & 322)

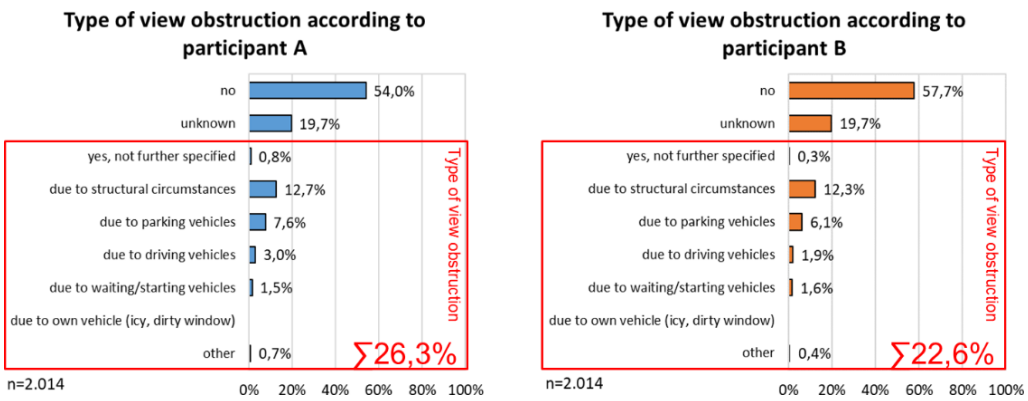

Figure 50: Type of view obstruction (302)

5.1.12 I) Used lane when encountering an accident

Figure 51 to Figure 53 show which lane the participants took when encountering an accident. The majority of this crossing traffic accident scenario participants were driving at a single lane road.

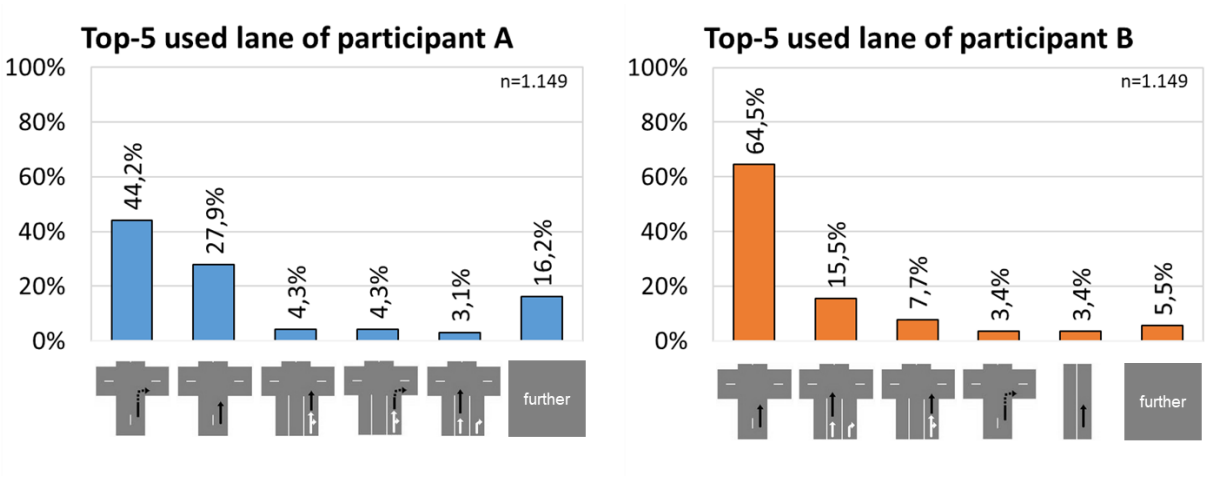

Figure 51: Used lane at an accident (301 & 303)

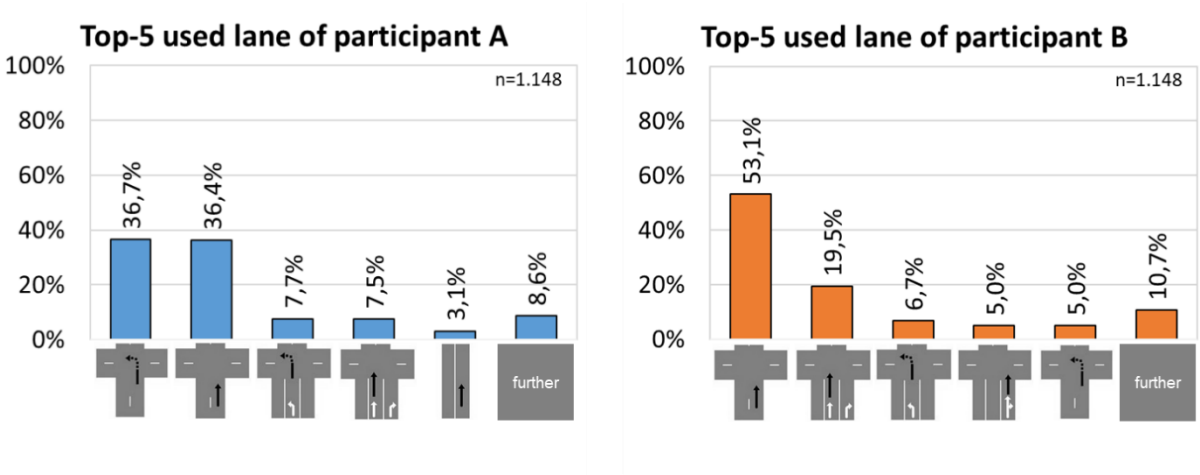

Figure 52: Used lane at an accident (321 & 322)

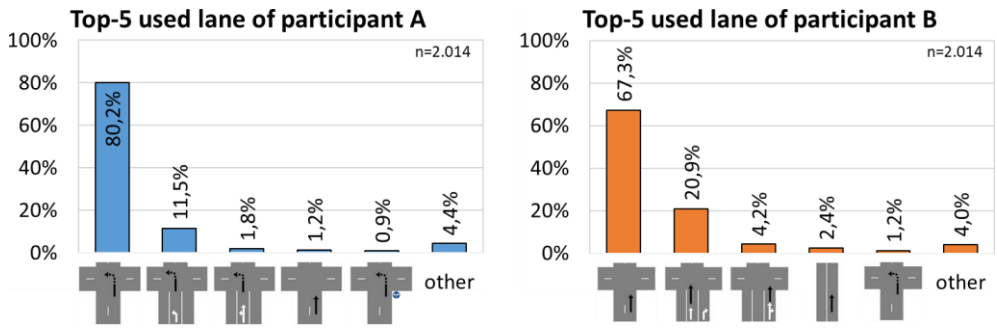

Figure 53: Used lane at an accident (302)

5.1.13 m) Road surface

Figure 54 to Figure 56 shows which kind of road surface it was when encountering an accident. The majority of crossing traffic accident scenario participants were driving at a conventional asphalt road. For Participant A, a paving / cobble stoned road maybe mean that they drove there before entering the main road.

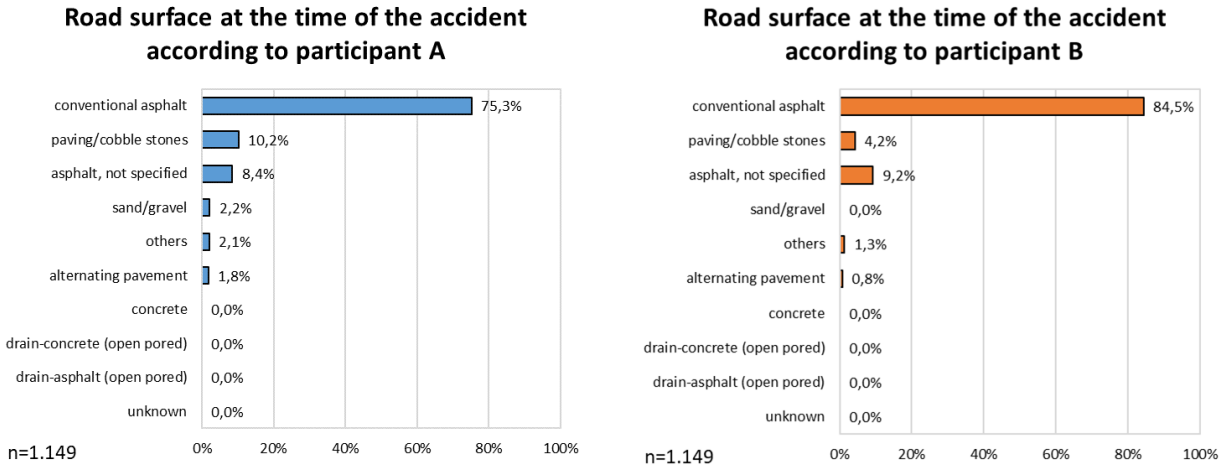

Figure 54: Road surface (301 & 303)

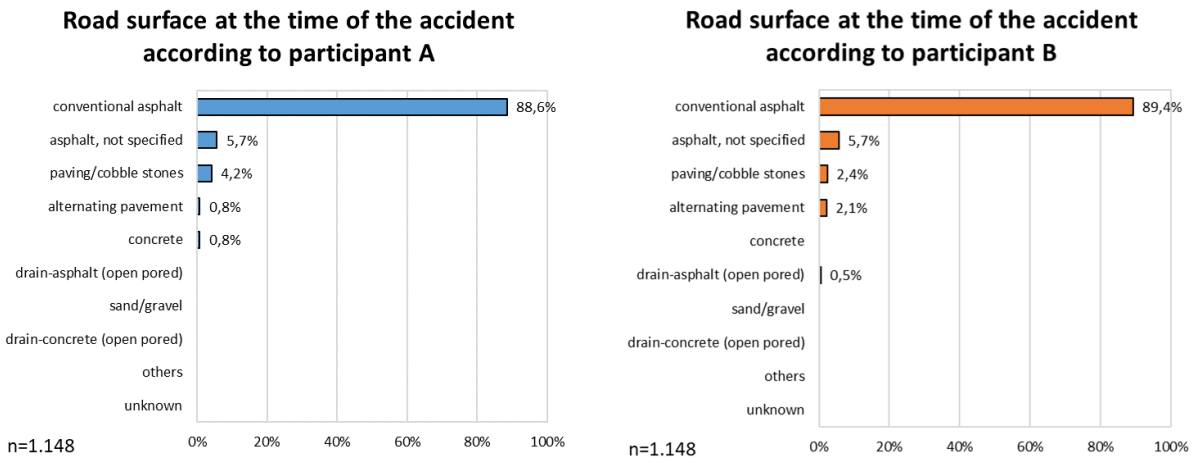

Figure 55: Road surface (321 & 322)

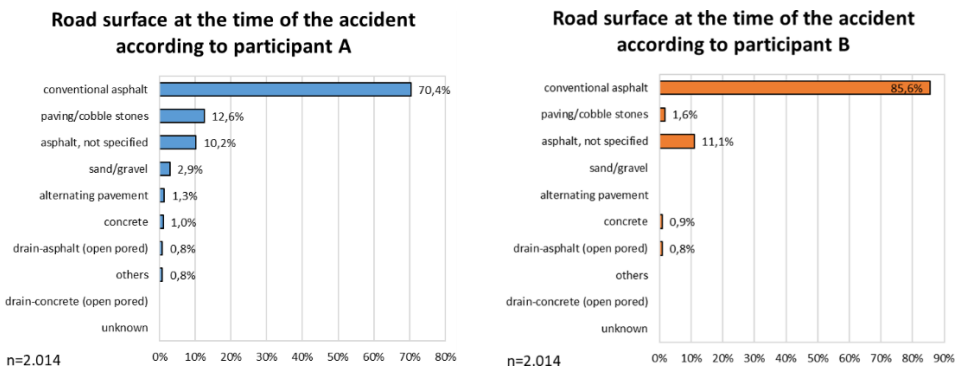

Figure 56: Road surface (302)

5.1.14 n) Precipitation at the time of the accident

Figure 57 to Figure 59 shows precipitation at the time of the accident. From these figures, it can be observed that in most accidents it was not raining.

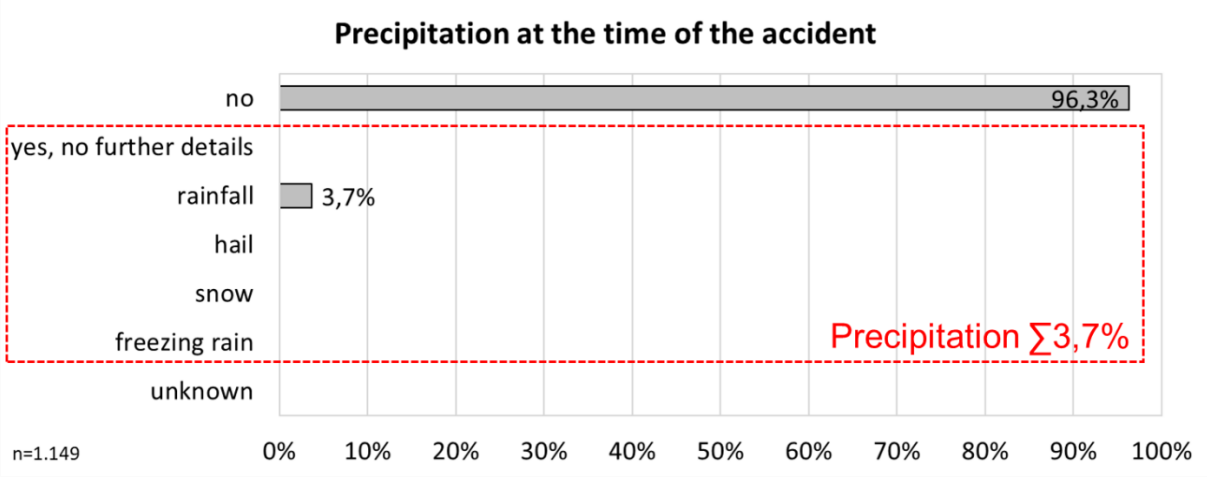

Figure 57: Precipitation (301 & 303)

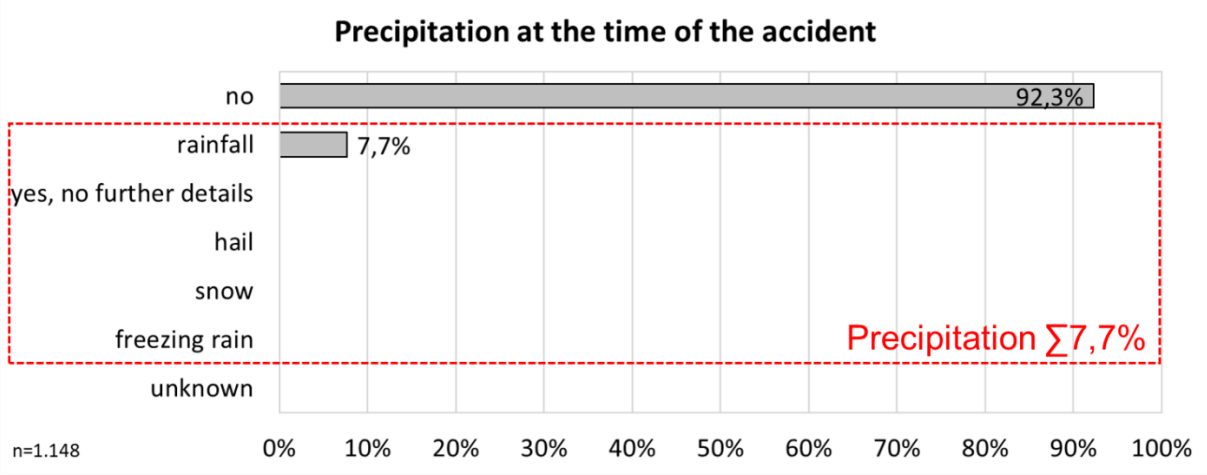

Figure 58: Precipitation (321 & 322)

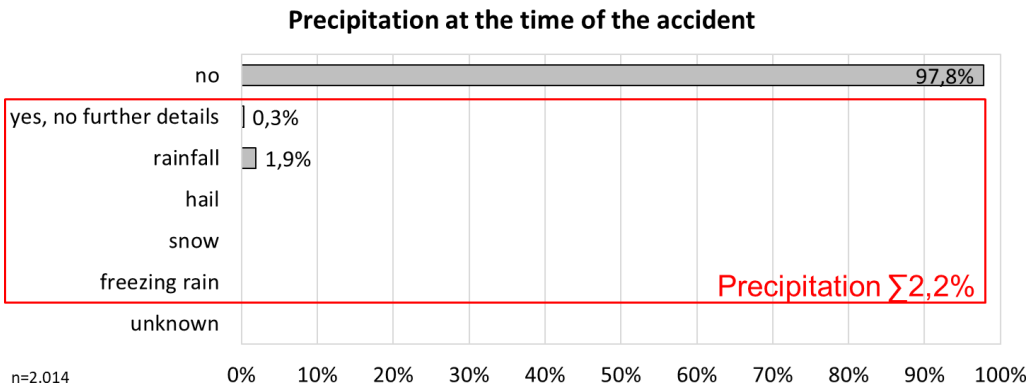

Figure 59: Precipitation (302)

5.1.15 o) Road condition

Figure 60 to Figure 62 shows the road condition at the time of the accident. From these figures, it can be observed that most accidents were with dry road surface which would allow full brake performance.

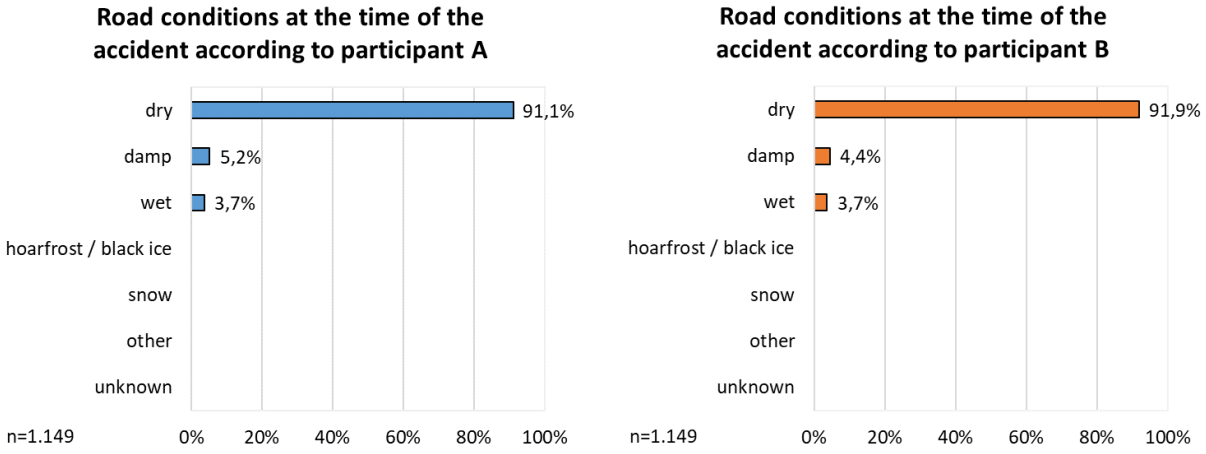

Figure 60: Road condition (301 & 303)

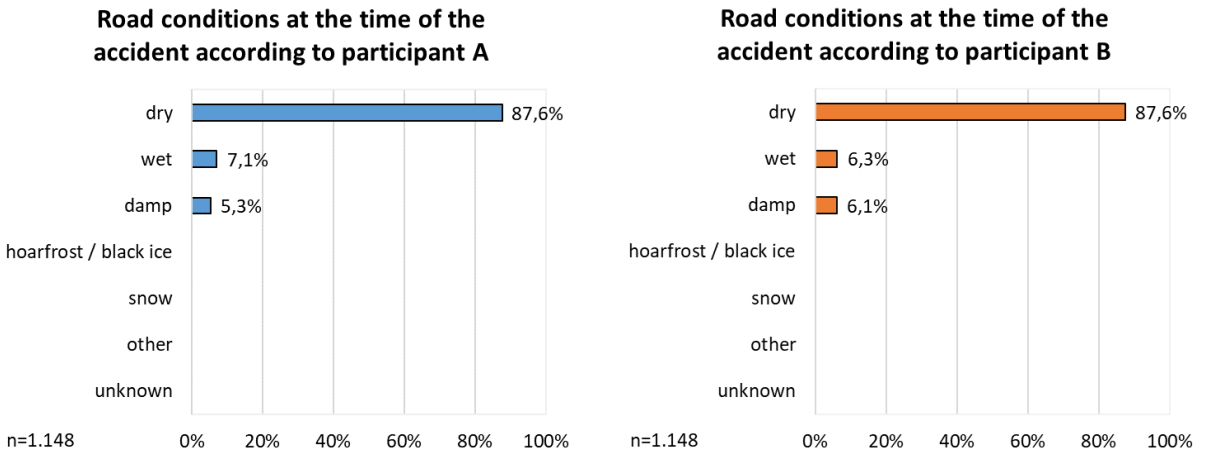

Figure 61: Road condition (321 & 322)

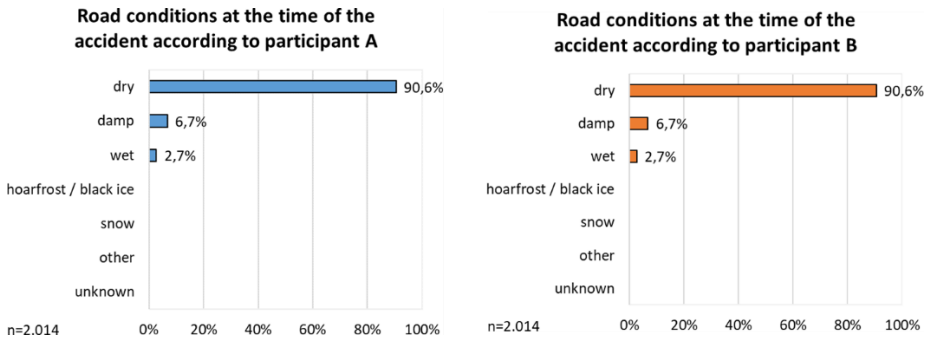

Figure 62: Road condition (302)

5.1.16 p) Cloudiness at the time of the accident

Figure 63 to Figure 65 show cloudiness at the time of the accident. From these figures, it can be observed that the sum of no clouds and few clouds accounts for more than 50%. Cloudiness seems not a huge factor regarding accidents.

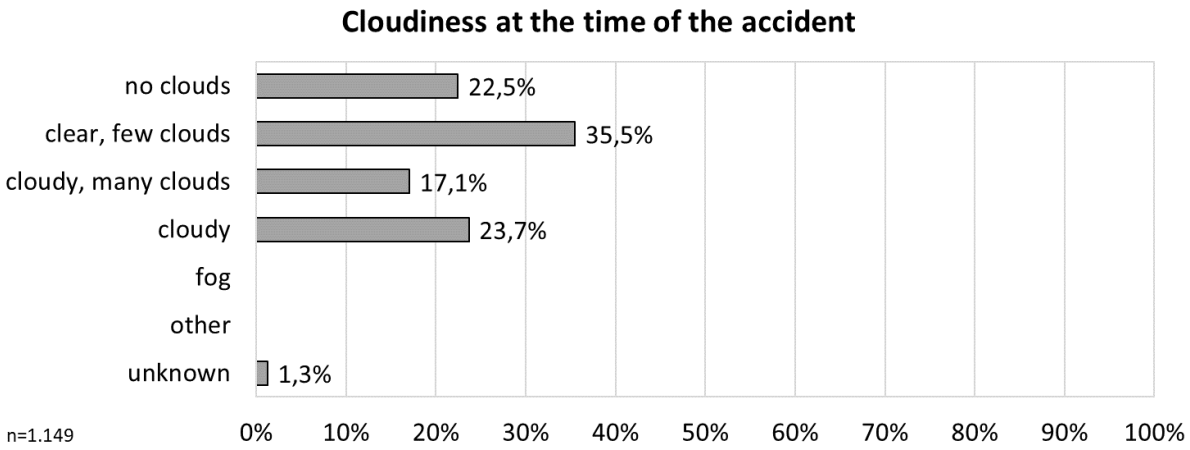

Figure 63: Cloudiness (301 & 303)

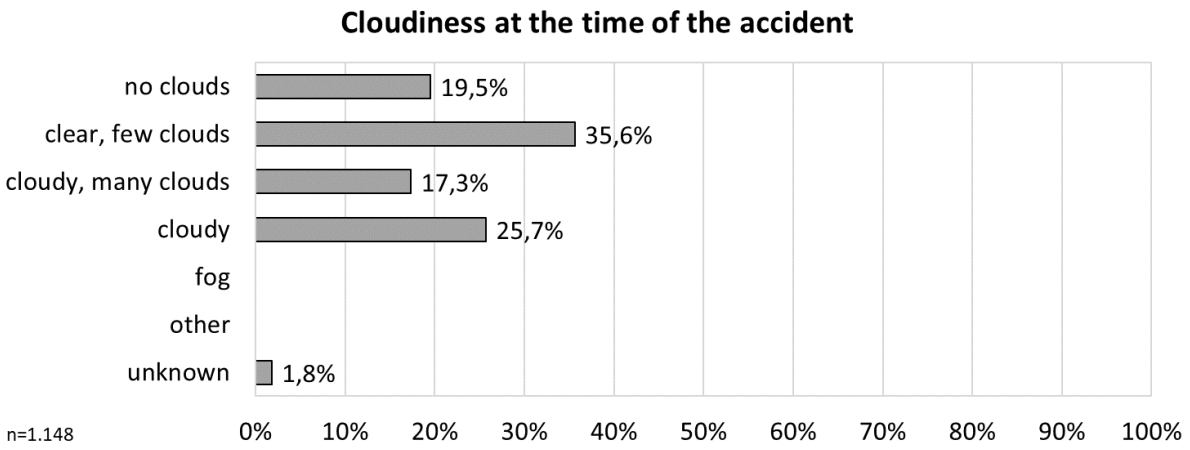

Figure 64: Cloudiness (321 & 322)

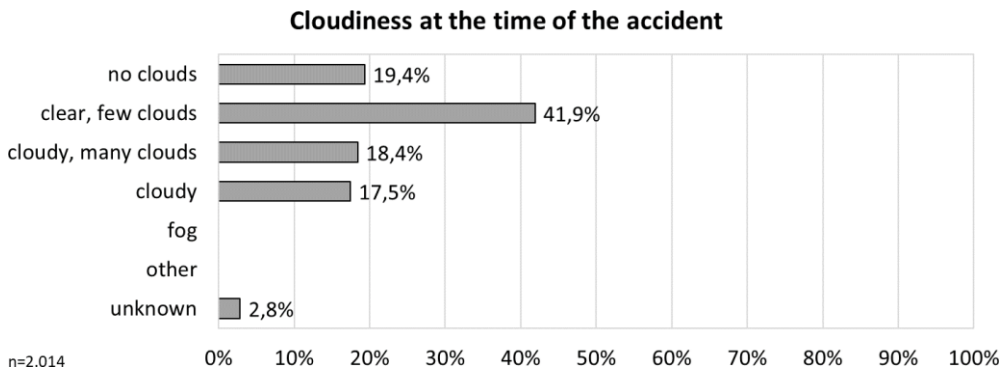

Figure 65: Cloudiness (302)

5.2 Crossing traffic accident analysis at roundabouts

As mentioned in 5.1.2 , roundabouts are a distinctive accident scene of accident types 301 & 303. The details of the accident analysis results are shown in the next paragraphs.

5.2.1 Injury severity

The left graph in Figure 66 shows the injury severity of all accidents of the combination 301 & 303. In almost 3/4 of all those accidents, participants are slightly injured and in over 1/4 of the accidents, participants are seriously injured. 2% are accidents with fatalities.
The right graph in Figure 66 shows the injury severity of accident type 301 & 303 in roundabouts. In 91% of those accidents, people are slightly injured and only in 9%, people are seriously injured.

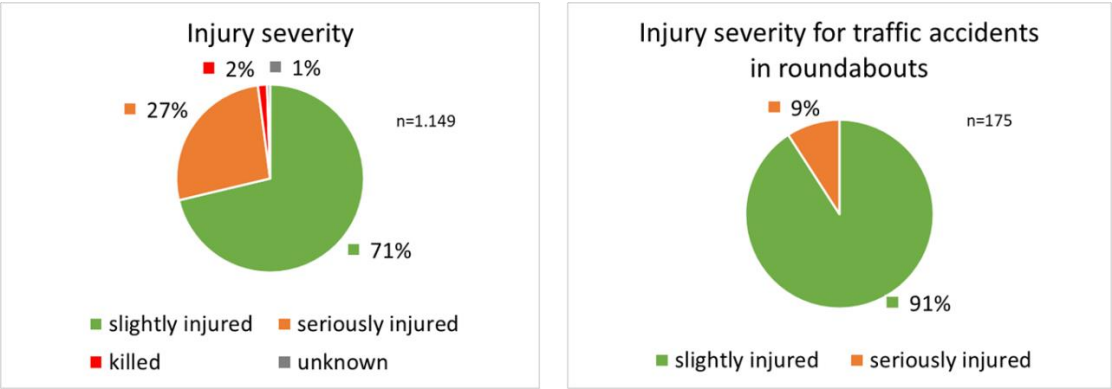

Figure 66: Injury severity (301 & 303)

5.2.2 Speed before the accident and at the time of collision

The initial speed of Participant A in case of accidents of the combination 301 & 303 is shown in Figure 6.7; the graph on the left side shows all those accidents and the graph on the right side shows those in roundabouts.
In roundabouts, the initial speed of Participant A is 12 km/h higher as compared to all accidents of the combination 301 & 303.

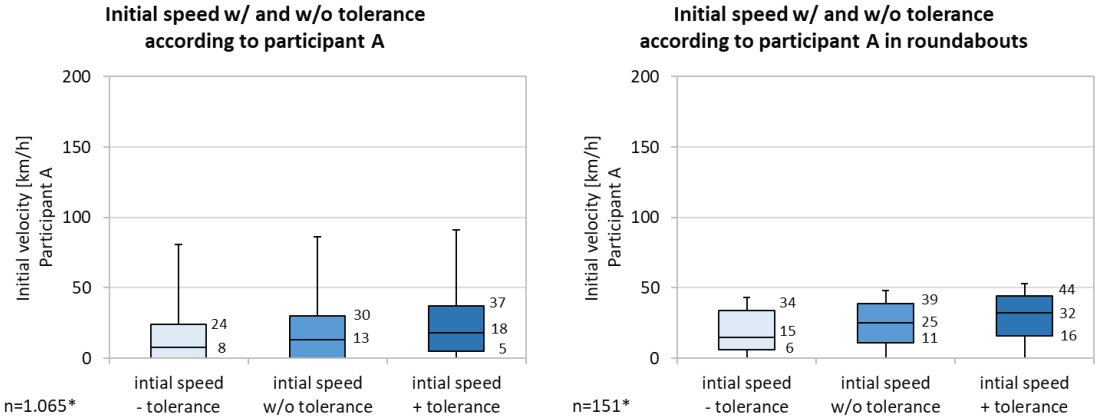

Figure 67: Initial speed of Participant A (301 & 303)

The initial speed of Participant B is shown in Figure 68. In roundabouts, the initial speed of Participant B is 15 km/h lower as compared to all accidents of the combination 301 & 303.

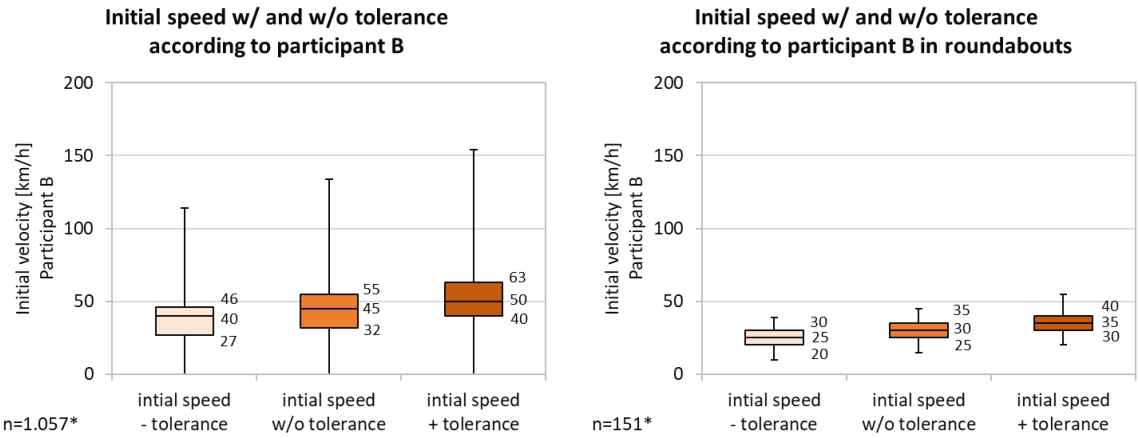

Figure 68: Initial speed of Participant B (301 & 303)

The collision speed of Participant A is shown in Figure 69. In roundabouts, the collision speed of Participant A is 4 km/h lower as compared to all accidents of the combination 301 & 303.

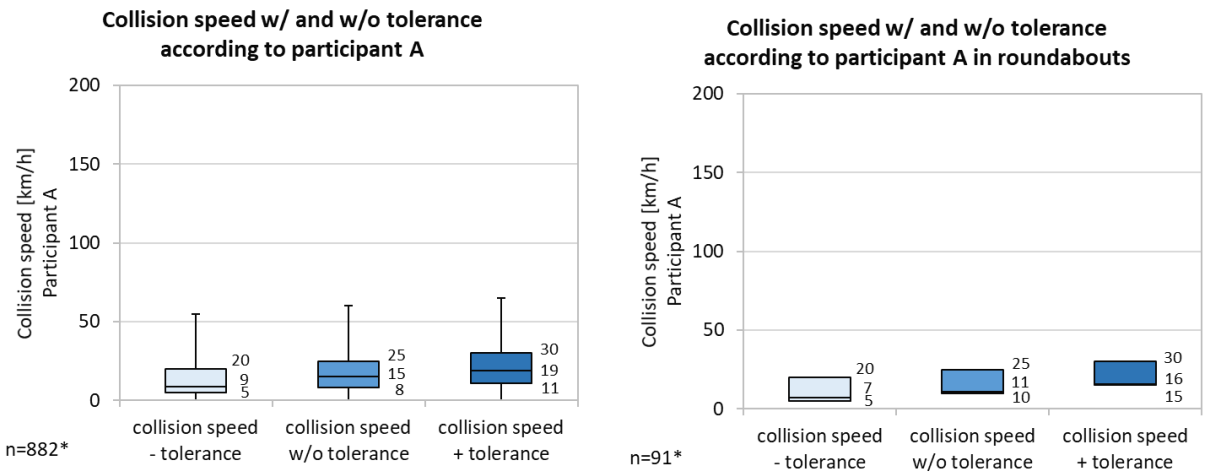

Figure 69: Collision speed of Participant A (301 & 303)

The collision speed of Participant B is shown in Figure 70. In roundabouts, the collision speed of Participant B is 10 km/h lower as compared to all accidents of the combination 301 & 303.

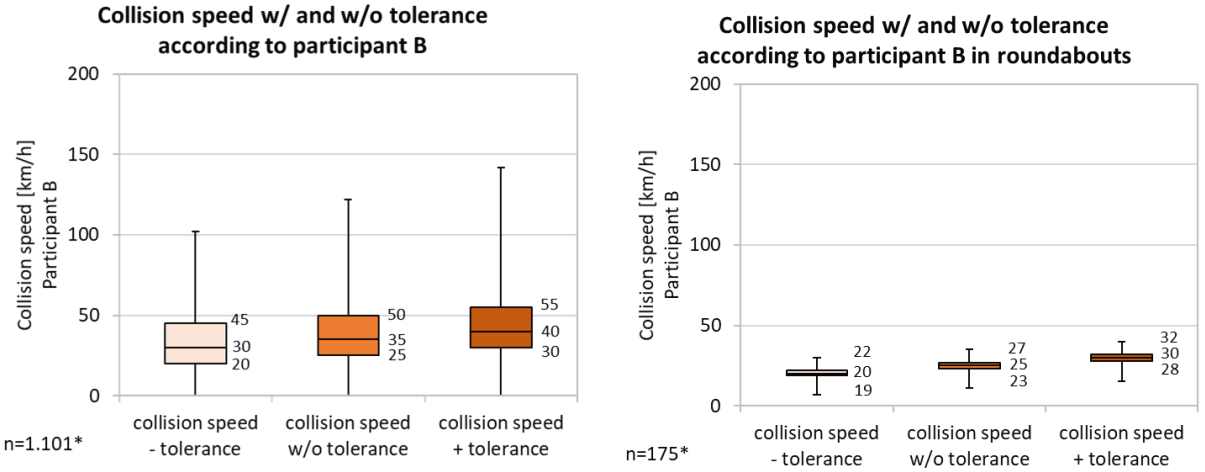

Figure 70: Collision speed of Participant B (301 & 303)

6. Conclusion

CMC analysed crossing traffic accident type 302 in an earlier document. In the current document, CMC analysed crossing traffic accident types 301 & 303 and 321 & 322 in detail based on the GIDAS database. The database provides insights into a great number of aspects of each reported accident; for example road conditions, speed, visibility of the participants etc. In this analysis, a total of 16 potential influencing factors were investigated and reported, including the ones that eventually did not appear to have an important contribution to the accident.
From the analysis, an important outcome is that there was no view obstruction in approximately 70% of the cases, but still Participant A (mainly cars/ trucks) overlooked Participant B (mainly PTWs) or misjudged the situation. It is assumed that the situation has led to a collision due to a missed opportunity or late timing to take avoiding action at the correct time. This implies that there is a need for technology support to inform Participant A of the existence of oncoming Participant B.

Abbreviations

CMC	Connected Motorcycle Consortium
GIDAS	German In-Depth Accident Study
PTW	Powered Two-Wheeler